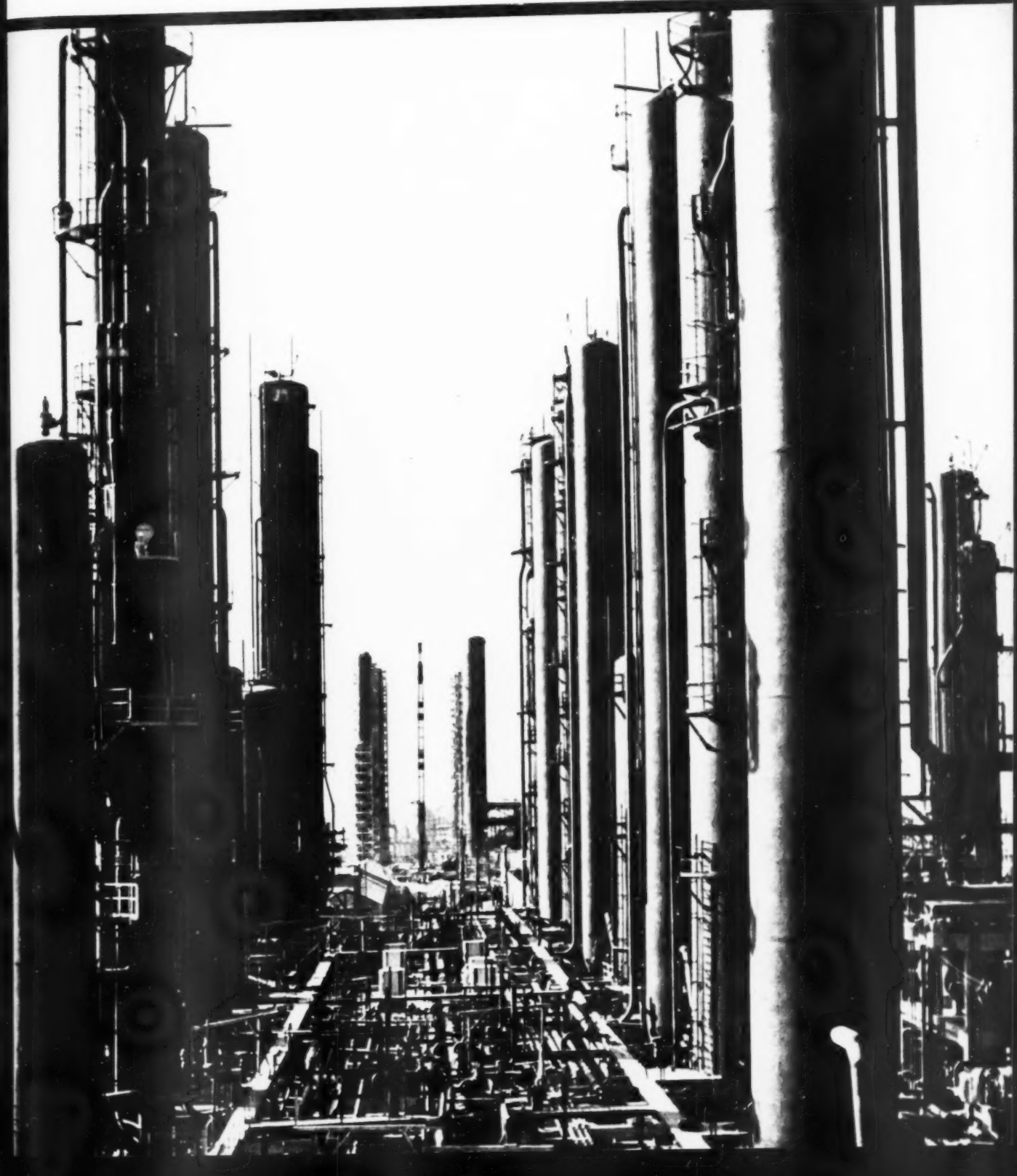
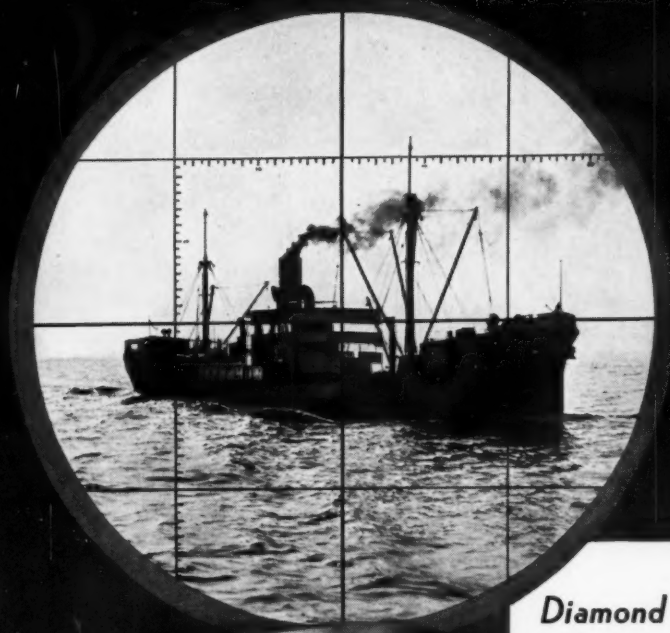
January 1944

TECHNOLOGY REVIEW

Title Reg. in U. S. Pat. Office



NORTON *Diamond Wheels* HELP SINK ENEMY SHIPS



Diamond Wheels Have Put Optical Glass on a Mass Production Basis

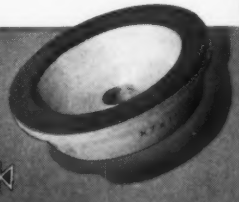
The war's sudden demand for thousands upon thousands of lenses and prisms for binoculars, range finders, periscopes and other instruments literally swamped former methods of producing these optical products. The answer—Norton Diamond Wheels now grinding glass in high production, both in roughing operations and to a transparent finish.

In countless applications Norton Diamond Grinding Wheels are meeting the challenge of war.

•

Norton Company, Worcester 6, Mass.

Behr-Manning, Troy, N. Y., is a Norton Division



NORTON ABRASIVES

He was a MASTER MECHANIC

. . . an avoidable eye injury robbed him of his much-needed skill

PROTECT YOUR WORKERS WITH AO GOGGLES

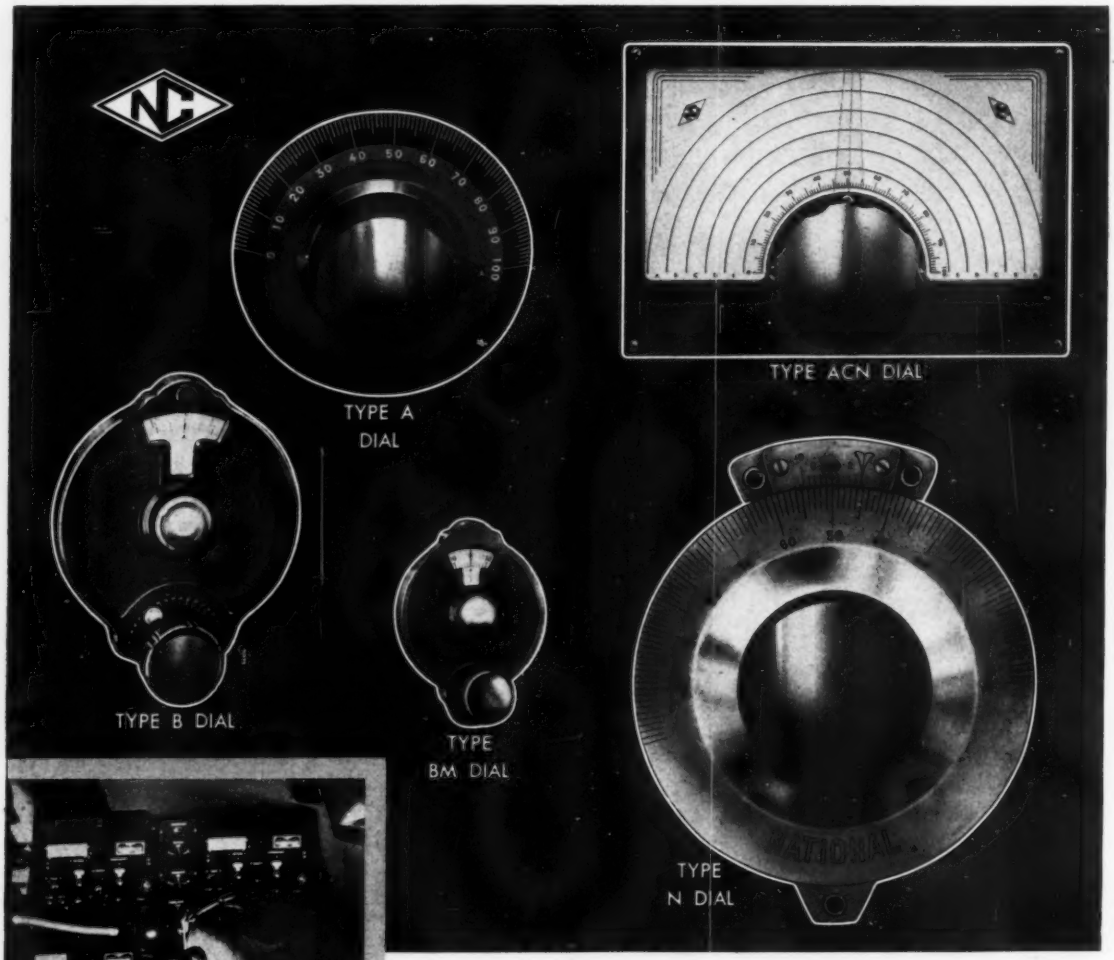
In *split-seconds,* injuries to unprotected eyes can cost you the services of workers you have spent years training . . . workers who are practically irreplaceable today.

To avoid "Lost-Time-Eyes" in your plant, AO offers a wide line of comfortable, light, cool safety goggles. An investment in AO Goggles is quickly returned in saved manpower, added production, improved efficiency, and decreased costs.

A strong offense is your best defense against eye accidents. Take the initiative in establishing and maintaining a time-and-money-saving goggle program in your plant. Get in touch with your nearest AO Branch . . . located in all principal industrial cities . . . or have an AO Safety Representative call at your office.

American Optical
COMPANY
SOUTHBRIDGE, MASSACHUSETTS
World's Largest Manufacturers of Products to Aid and Protect Vision

THE TECHNOLOGY REVIEW, January, 1944. Vol. XLVI, No. 3. Published monthly from November to July inclusive at 10 Ferry Street, Concord, N. H. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription $4.00. Entered as second-class matter at the Post Office at Concord, N. H., under the Act of March 3, 1879.



The photograph immediately above shows an installation inside a Pan-American Clipper. National Dials have been a favorite with Pan-American Airways for many years.

TYPE N DIAL—Four-inch diameter with engine divided scale and flush vernier. 5 to 1 ratio.

TYPE ACN DIAL—Designed for direct calibration. Dial bezel size 5" x 7¼".

TYPE B DIAL—Compact, variable-ratio drive inclosed in bakelite case. Illuminator available.

TYPE BM DIAL—Similar to Type B, but smaller in size and having a fixed ratio.

TYPE A DIAL—The Original Velvet Vernier Dial, an unchallenged favorite for twenty years.

ACCURACY —and VELVET DRIVE

In War as in Peace, National Dials provide the smooth effortless control that makes the operator master of his equipment. Enormous increases in our productive capacity are meeting wartime demands, and National Dials are available with reasonably prompt delivery to users having the necessary priority.

NATIONAL COMPANY, INC.

MALDEN, MASS.

today's signs forecast tomorrow's needs

It will be a changed world. Some may think that the nation's chemical and petro-chemical equipment for war will serve adequately for the needs of peace. But still greater accomplishments are possible. And the inevitable struggle for competitive post-war advantage will certainly develop them.

Good as war-built plants and equipment may be, it is not enough to rest on their pattern. Reconversion or refitting for peacetime requirements calls for study *now*.

Adding to the experience of a long pre-war career, Badger has learned much during the past three years of handling many construction projects — small and large — for the manufacture of high octane gasoline, synthetic rubber stocks, explosives, and all sorts of chemicals, new and old.

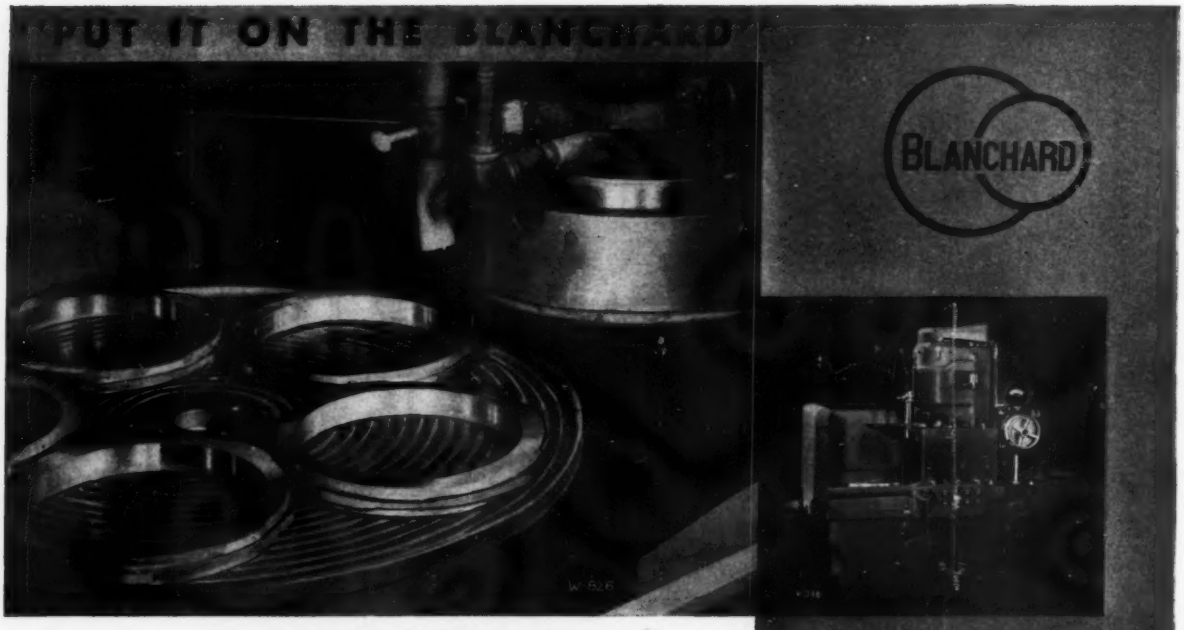
This rich experience is available to you in change-over, modernization or new-plant undertakings. Badger is equipped to handle *everything* — either under sole responsibility or in co-operation with your own organization . . . from process, design and construction engineering, to material procurement, to labor employment and supervision, down to test-run operation. Badger is open for discussions now.

E. B. Badger & SONS CO.

BOSTON **Est. 1841**

NEW YORK ● PHILADELPHIA ● SAN FRANCISCO ● LONDON

PROCESS ENGINEERS AND CONSTRUCTORS FOR THE CHEMICAL, PETROLEUM AND PETRO-CHEMICAL INDUSTRIES



Grinding Nickel Steel Cams on the
No. 18 Blanchard Surface Grinder

These nickel steel Cams are finish ground on the No. 18 Blanchard Surface Grinder.

.040" to .060" of stock is removed from one side of these cams to limits of ±.001". 109 pieces are produced per hour.

This is only one of the many airplane engine parts ground on the Blanchard. Some are held in fixtures; magnetic, hand-clamping or automatic.

Send your blueprints for production estimates.

The BLANCHARD
MACHINE COMPANY
64 STATE STREET, CAMBRIDGE 39, MASS.

CHECK THESE ADVANTAGES OF BLANCHARD GRINDING

★ **Production**

Adaptability

Fixture Saving

Operation Saving

Material Saving

Fine Finish

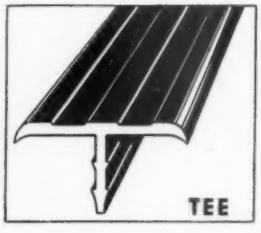
★ **Flatness**

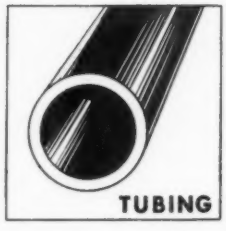
Close Limits

★ *. . . Especially valuable on jobs like the one illustrated.*

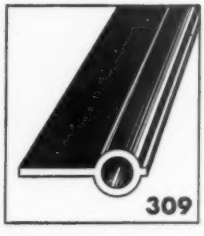
Send for your free copy of "Work Done on the Blanchard." This book shows over 100 actual jobs where the Blanchard Principle is earning profits for Blanchard owners.

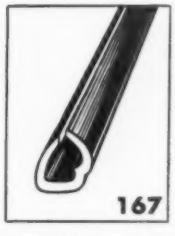
STOCK DIE SECTIONS



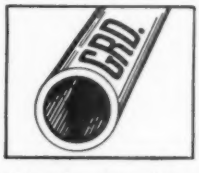


TYPICAL CUSTOM SECTIONS





Sandee
EXTRUDED PLASTICS



Vinyl sleevings in black, clear or N.E.M.A. colors can now be cut to any lengths (from ⅛" to 6½") and IMPRINTED in one operation! Send for quotations on your needs.

Sandee has rapidly become one of America's largest extruders of thermoplastics. Here, every facility is available to render a highly efficient service:

1. Capable, long-experienced plastics engineers;
2. Thermoplastic materials and compounds of every description;
3. Expert tool and die makers;
4. Modern extrusion machines;
5. Exclusive Sandee methods of manufacture;
6. Fine tolerances employed assure meeting exacting specifications;
7. Absolute uniformity of size and finish; and,
8. Surprisingly prompt shipments in the face of difficult war conditions.

Sandee now serves our country's largest users of extruded plastics. Consult our engineers on your problems. Write today for samples and moderate cost estimates.

ELMER SZANTAY, M.E. '35, GENERAL MANAGER

Sandee Manufacturing Company

3945 NORTH WESTERN AVENUE • CHICAGO, ILLINOIS

EXTRUDED PLASTICS AND SPECIAL TOOLS

AM-105 U. S. S. PIONEER

She Has Good Stuff in Her

She has to have. The U.S.S. Pioneer is one of our Navy's mine sweepers. Cruising around in quest of enemy mines keeps a sailor on his toes. Naturally, he feels confident when he knows he can rely on his ship. We're proud to say that the U. S. S. Pioneer is propelled by Diesel engines—made by the same Busch-Sulzer skilled workmen who are turning out precise ammunition hoists for the Navy's 5″/38 caliber guns . . . and engines for other naval and army craft, as well as engines for the U. S. Maritime Commission. Until this war program is completed, we can accept orders of high priority only for engines from 450 to 3600 horsepower.

BUSCH-SULZER BROS.—DIESEL ENGINE COMPANY
ST. LOUIS

AMERICA'S OLDEST BUILDER OF DIESEL ENGINES

BUSCH-SULZER ST. LOUIS

Another FIDELITY Machine—
covers wire or strip—at double pre-war speeds

Not only the bottle-neck of wire insulation, but other similar ones in covering round or flat rods of metal, plastic or other materials with cotton, linen or other fibres, have been removed by FIDELITY SINFRA Machine. In some cases, output was upped as much as 300%.

Still restricted to war production applications, these FIDELITY Machines will ultimately contribute just as effectively to peace-time manufacturing. If you face this kind of problem, either now or when competition returns, it is probable you can get a quick solution at FIDELITY.

Whatever the problem, if it indicates a need for a special-purpose machine of the automatic, precision type, you can start preparing for the day of transition now by bringing it here where a skilled and experienced engineering staff is backed up by unusual shop facilities.

FIDELITY has designed and built a wide variety of machines for many purposes. This experience and the manufacturing equipment available are described in an interesting, well-illustrated book.

BUY MORE BONDS

ARMY E NAVY

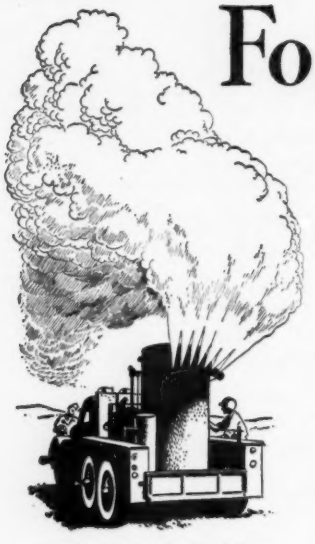
32 YEARS' EXPERIENCE

Designers and Builders of Intricate, Automatic Precision Machines

FIDELITY MACHINE COMPANY

3908-18 FRANKFORD AVENUE, PHILADELPHIA 24, PA.

Foothold *in a Fog*



Smoke Generator in Action

Good weather is bad weather for an invasion.

When American troops land on enemy beaches, it's often under cover of a friendly life-saving "fog."

American scientific and engineering ingenuity provided the equipment for our forces to make their own special invasion weather. For the "fog" is produced artificially by mobile smoke generators which blanket whole areas in an impenetrable white mist.

Months ago, the National Defense Research Committee enlisted the help of General Electric research scientists in developing an improved smoke generator for the Chemical Warfare Service.

Nobel prize winner Dr. Irving Langmuir and his associates evolved a new principle of smoke generation, upon which the Standard Oil Development Company designed and built the equipment. The smoke it produces is harmless; it doesn't even soil clothes. But it does keep our troops and their movements from the sharp eyes of enemy aircraft.

This smoke generator, which according to reports has saved lives in Allied landings wherever it has been used, is another example of American industry's research and engineering and manufacturing skill. Producing superior weapons for our troops today, these same resources will be available for all the American people tomorrow in building a better world. *General Electric Co., Schenectady, N. Y.*

192,000 employees of General Electric are buying over a million dollars of War Bonds every week.

GENERAL ELECTRIC

Hear the General Electric radio Programs: "The G-E All-girl Orchestra" Sunday 10 p.m. EWT, NBC —"The World Today" news, every weekday 6:45 p.m. EWT, CBS.

The Spark that Lights the Flame of Victory

A pinpoint of fighting metal placed in the arc of the spectrograph writes its own signature on a photographic plate. Inside the instrument, the light from that flame is broken up by a prism as a prism breaks up sunlight. Each element identifies itself by a series of characteristic lines, always the same for the same basic element. It reveals to the spectrographer each constituent, what impurities are present and in what quantities.

Thus spectrography helps in controlling inspection. It keeps tough fighting steels tough, helps in development of new fighting metals. Spectrography is used too in other fields . . . chemicals, foodstuffs, vitamins. It speeds research, control, and analysis. Today, spectrography is helping to build the tools of Victory as in peacetime it helps to make better cars and better breakfast foods.

Because Bausch & Lomb had long experience with such precision optical equipment needed in education, research, and industry, it was ready for quantity production of precision optical instruments of war such as gunfire control instruments, binoculars, and aerial photographic lenses. When the last gun is fired, Bausch & Lomb will devote its enlarged experience to peacetime optical production. Through war and peace, Bausch & Lomb has continued . . . and will continue . . . to do the job it knows how to do best. *Here again optical science is seeing it through.*

For Bausch & Lomb Instruments essential to Victory—priorities govern delivery schedules.

BAUSCH & LOMB

OPTICAL CO. • ROCHESTER, N. Y.

ESTABLISHED 1853

AN AMERICAN SCIENTIFIC INSTITUTION PRODUCING OPTICAL GLASS AND INSTRUMENTS FOR MILITARY USE. EDUCATION. RESEARCH. INDUSTRY AND EYESIGHT CORRECTION

Give them **Extra** Care

. . . to Get **Longer Tool Life**

Give tools a little extra care. Don't drop or throw them loosely into a drawer. Keep fine tools in the boxes in which they are packed and do not measure moving work or in places where a tool may be injured by a revolving cutter.

A little extra care from every tool user will increase tremendously the number of tools available and help at the same time to increase production.

BROWN & SHARPE TOOLS

BATH

IRON WORKS

CORPORATION

Shipbuilders and

Engineers

•

BATH, MAINE

THE TABULAR VIEW

Cautiously. — Few nonmilitary postwar matters promise more in potentiality or in difficulty than does that of aviation. There is satisfaction, hence, in presenting in this Review (page 137) a vigorous discussion of probabilities as against utopian possibilities in the skies for the years directly after peace. S. PAUL JOHNSTON, who through most of the years since his graduation from the Institute in 1921 has been closely concerned with aeronautical affairs, is Washington manager for the Curtiss-Wright Corporation. Offering a business view of a major phase of the general problem, Mr. Johnston's article affords valuable comparison with L. Welch Pogue's presentation of an administrative view of a similarly important phase in The Review for December. It will constitute a chapter in Mr. Johnston's book, *Wings After War*, which Duell, Sloan and Pearce have scheduled for publication about April 1.

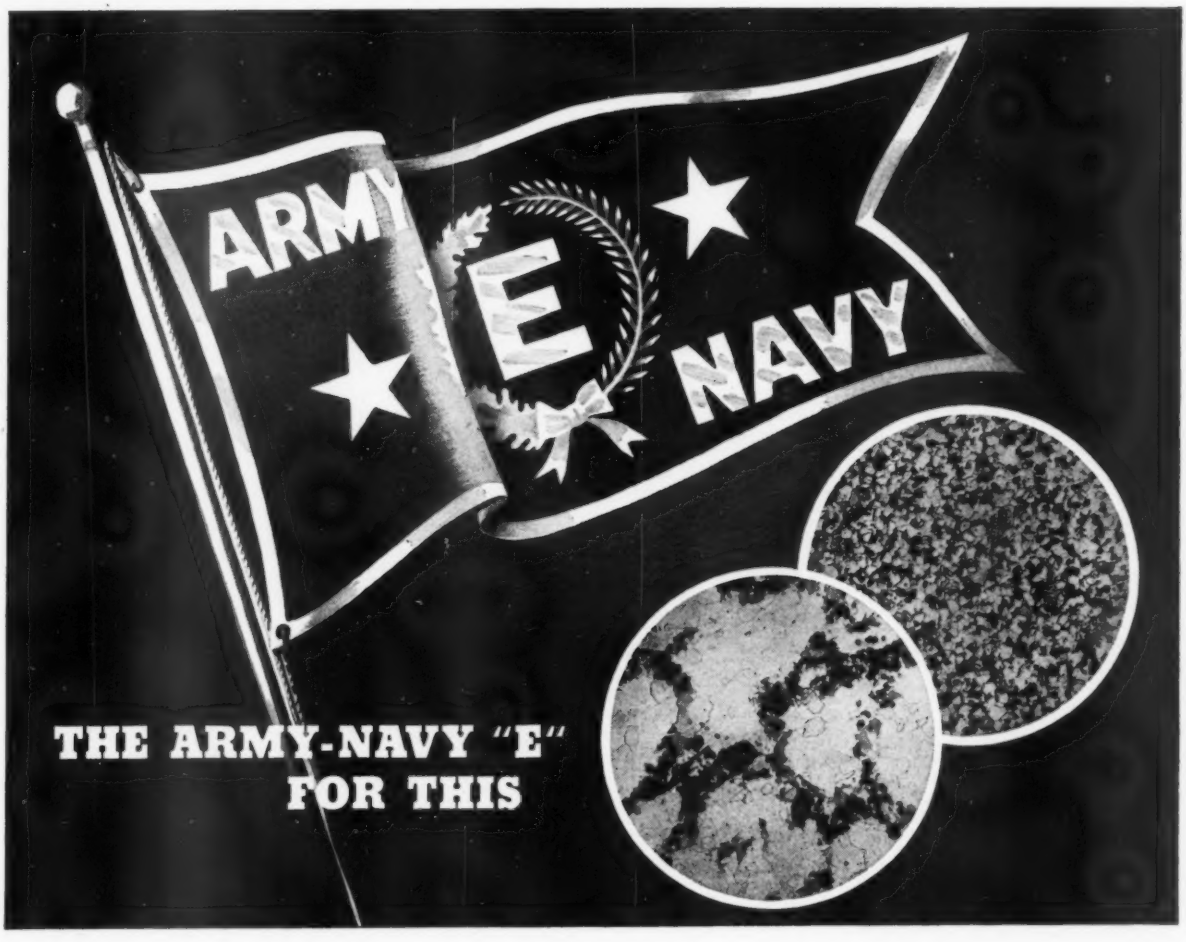
Ancestor. — One of man's distant kinsfolk is introduced to Review readers (page 139) in a graceful essay by M. F. ASHLEY MONTAGU, associate professor of anatomy, the Hahnemann Medical College and Hospital of Philadelphia, who is already familiar for varied contributions to our pages.

Comparison. — From his wide study of Civil War times, GEORGE FORT MILTON presents a footnote to military history (page 141) in pungent contrast to the history being made by American wartime industry today. Mr. Milton, formerly editor of the *Chattanooga News*, is the author of several volumes on the Nineteenth Century history of the United States, most recent among which is *Abraham Lincoln and the Fifth Column*.

Denomination. — Editorial Associate of The Review, EDWARD R. SCHWARZ in this issue chronicles (page 143) some interesting historical garnerings incidental to his professional activities as professor of textile technology at the Institute. Professor Schwarz, who was graduated from Technology in 1923, has written often for The Review both on the science and engineering involved in the development of textiles and on the philosophical and aesthetic values of fabric and fiber.

Earlier. — The time of origin of many an implement or process is often found to be subject to revision. Rarely, however, is this fact regarded as applicable to electrical affairs. That it may be is suggested (page 134) by DAVID O. WOODBURY, '21, who in the years since his graduation from the Institute has written widely on topics in science and engineering.

Versatile. — The career of Thomas A. Watson was one of many facets: He shared in the development of the telephone, was a student of geology at the Institute and of Shakespeare in England, was inventor and philanthropist, mechanic and artist. MERTON L. EMERSON, who writes appreciatively of this versatile life (page 146) from acquaintance with Mr. Watson, was graduated from the Institute in 1904 and maintains active leadership in alumni affairs.



On September 5th, 1942, our Mine and Mill at Climax, our Research Laboratory at Detroit and our Conversion Plant at Langeloth, Pennsylvania, were given the Army-Navy Production Award. Since then the award has been twice renewed. The two-starred flag we fly represents a full year of contribution to the war effort recognized by the Army and Navy.

Winning the award by the laboratory began in 1931. It was then that it was founded to meet our needs for authoritative information about molybdenum—containing ferrous materials.

Pearl Harbor intensified our work with producers of war equipment—work that is aided considerably by the accumulated data and experience gained in over ten years of concentrated research.

We are particularly proud to be among those companies whose laboratories are entitled to fly the Army-Navy "E".

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company

500 Fifth Avenue · New York City

MOLY

Today the STARRETT Name on a Precision Tool MEANS MORE THAN EVER

STARRETT standards of accuracy and workmanship have been steadfastly maintained. Today, as always, the STARRETT name on a Micrometer, a Vernier Caliper or Height Gage, Dial Indicator or any fine measuring tool, gives its user that familiar feel of confidence and respect that means more and better work.

The makers and distributors of Starrett Tools are doing everything possible to place these tools in the hands that need them most.

Now, with Service Star

THE L. S. STARRETT CO., Athol, Massachusetts, U. S. A.

WORLD'S GREATEST TOOLMAKERS

STARRETT

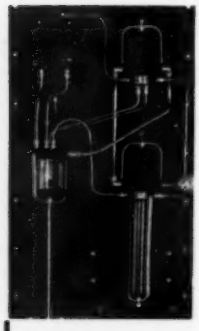
PRECISION TOOLS • DIAL INDICATORS • GROUND FLAT STOCK
HACKSAWS • METAL CUTTING BANDSAWS • STEEL TAPES

CAMBRIDGE

AUTOMATIC and CONTINUOUS

GAS ANALYSERS

. . . For the Process Industries



Cambridge **Recording** Gas Analysers insure accuracy and trouble free performance to a degree hitherto unknown. Completely automatic. Eliminate human error. No chemicals. No intermittent sampling. No moving parts in Cambridge analysis units. Combination units enable the continuous recording of several components of a gas, simultaneously, on a single chart. The Recorder can be furnished with contacts for various control or alarm actuating circuits and may be located at considerable distance from any sampling point. Cambridge analysers are used for the determination of

- O_2, H_2, CO_2, etc.
- COMBUSTIBLE GASES
- SPECIAL APPLICATIONS

Make use of our wide experience as producers of gas analysers for exacting industries. Send details of your problem to obtain our recommendations.

CAMBRIDGE INSTRUMENT CO., Inc.

3732 Grand Central Terminal New York 17, N. Y.

MAIL RETURNS

On Flood Control

The letter which follows reaffirms statements already published in the American Engineer *and other journals; they trenchantly express thought-provoking views on a subject of decided importance.* — ED.

FROM EDGAR A. WEIMER, '98:

About 1884 I became interested in hydraulics under the guidance of my father, P. L. Weimer, and my brother-in-law, John Birkinbine, whose father was the foremost hydraulic engineer in this country and the builder of Philadelphia's first water system. As a part of my engineering education, I spent considerable time and money building dams of all types on a rather large flood control project located on several farms acquired by my father in Schuylkill County, Pa., for the purpose of providing me with an experimental area.

Flood control interested me to such an extent that I have made it a study from that early date up to the present. From 1900 to 1902 I resided along the banks of the Mississippi and Tennessee rivers, and as this period was in one of the flood-period cycles, I had the opportunity of viewing the futile and anxious attempts of the government to control these rivers by dikes, or levees. Expenditures for this purpose, I am told, amounted to not less than fifty million dollars a year from prior to 1900 to the present time. To be sure, the project gives jobs to about 3,000 government engineers, but the harm done trying to combat nature's laws has never been given the study it should.

My failure to get engineers to look into the damaging side of the problem has made me only more positive that I am correct in my contentions. Nature provided bends in streams and rivers to retard the flow of water. The flooding of lands provides retarding storage basins and maintains the fertility of the lands by deposition of layers of mud.

(*Concluded on page 164*)

— STEEL —

HOT AND COLD ROLLED

DEFORMED BARS FOR CONCRETE

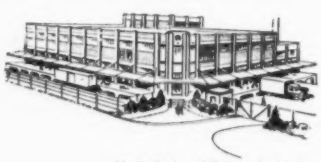
Stahleker Steel Corp.

Second and Binney Sts., Kendall Sq., Cambridge, Mass.

Telephone Trowbridge 1440

WALLACE BLANCHARD, '16, *Treasurer*

Speed with Economy



U. S. Industrial Chemicals, Inc.

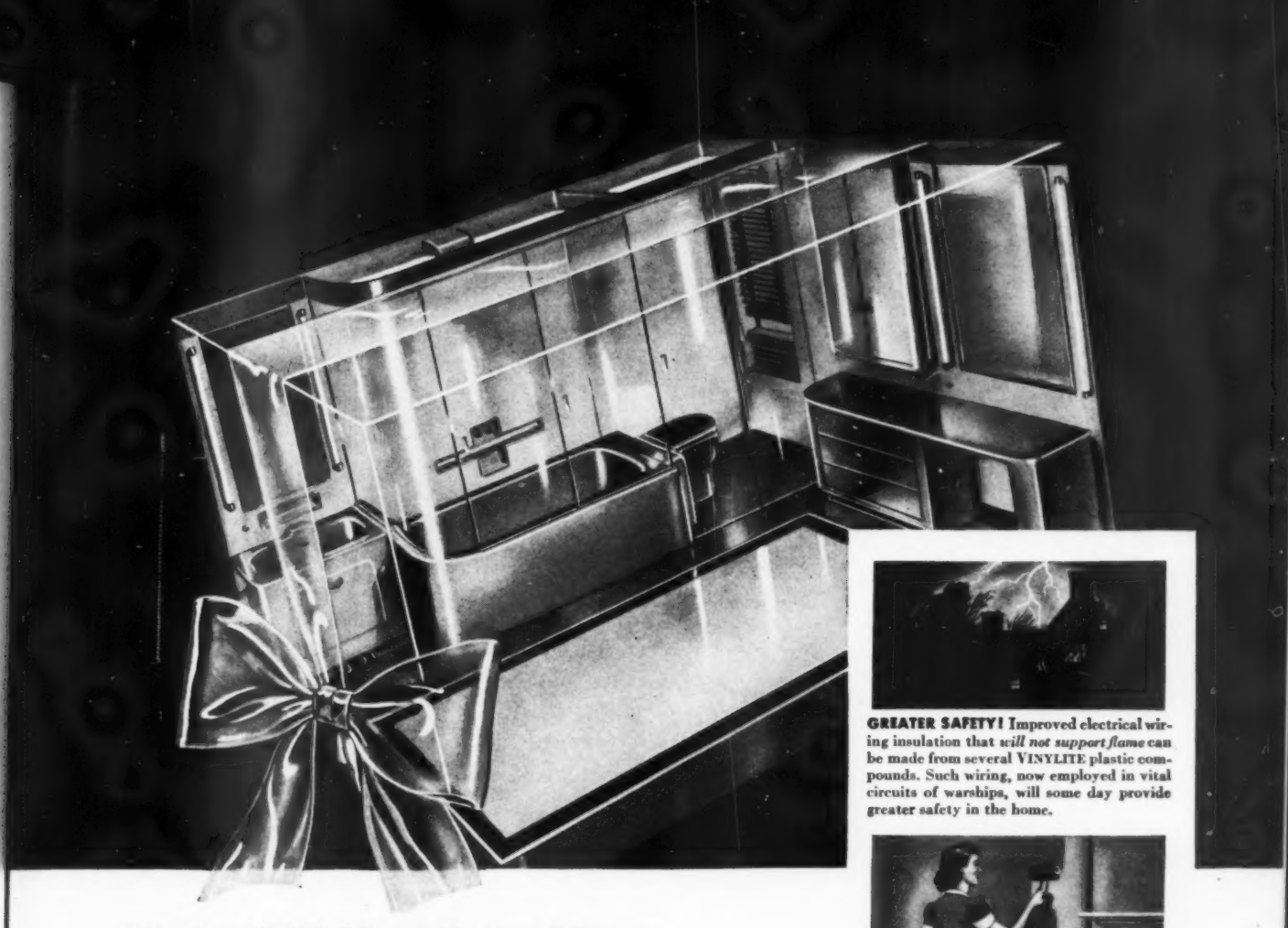
In our weekly "job meetings" each building operation comes up for examination in detail by our full staff, with complete minutes of each meeting sent to the owner. In this way, work is continuously planned ahead and coordinated.

W. J. BARNEY CORPORATION

101 PARK AVENUE, NEW YORK

INDUSTRIAL CONSTRUCTION

Alfred T. Glassett, '20, Vice President



Plastics Will Mean Better Homes

. . . *and more of them!*

EVEN TODAY, plastics men can vision a bathroom with practically everything in it made of plastics or containing plastics in some form. Imagine such a bathroom, costing less to manufacture, to ship, and to install, delivered *as a unit* to your home!

The raw materials to make better homes with more bathrooms and finer kitchens come true are *in existence today* . . . in VINYLITE and BAKELITE resins, and plastics made from them.

BAKELITE resin-bonded plywood, like that from which planes and torpedo boats are made, can be used to make floors, walls, ceilings, and furniture.

The type of plastic film used in waterproof, chemical-resistant food bags and rifle covers can be fabricated into mildewproof shower curtains. VINYLITE resins can also be made into rot-resistant floor coverings that can be walked on millions of times *without showing appreciable wear!*

Our engineers know from the record of VINYLITE plastic-coated life raft sails, sleeping bags, and life preservers, that VINYLITE plastics and compounds can be used in the future to bring you wall coverings, window curtains, and furniture finishes that will outlast anything now available.

Under heat and pressure, VINYLITE and BAKELITE plastics can be molded into numberless useful forms. Experience gained in molding war equipment will help to bring you such things as molded plastic furniture which will be lighter, easier to move, easier to keep clean!

Spun plastics made from vinyl resins are resistant to rot. Right now, such plastics are used for making jungle hammock ropes and vital chemical filters. They also can be fashioned into draperies, upholstery, stockings, and other articles of clothing ...sun-proof, water-proof, and moth-proof!

VINYLITE and BAKELITE resins and plastics, and many new techniques for using them, are peacetime research achievements of CARBIDE AND CARBON CHEMICALS CORPORATION and BAKELITE CORPORATION, both Units of UCC. Fabricators converting these raw materials into finished articles are making them mean more and more to you.

GREATER SAFETY! Improved electrical wiring insulation that *will not support flame* can be made from several VINYLITE plastic compounds. Such wiring, now employed in vital circuits of warships, will some day provide greater safety in the home.

MORE BEAUTY! New *washable* water paints based on BAKELITE resins, will bring new beauty to homes. These paints are inexpensive . . . and *easy to apply!*

LESS EXPENSE! Use of BAKELITE molding plastics in making washing machines, refrigerators, and many other household devices and fixtures can mean lower-priced, longer-lasting equipment for you.

LESS WORK! Easier cleaning of plastic-treated walls, ceilings, and floors. Plastic furniture and upholstery that are easier to keep clean. Yours in the future!

BUY UNITED STATES WAR BONDS AND STAMPS

UNION CARBIDE AND CARBON CORPORATION

30 East 42nd Street UCC New York 17, N. Y.

Principal Units in the United States and their Products

ALLOYS AND METALS
Electro Metallurgical Company
Haynes Stellite Company
United States Vanadium Corporation

CHEMICALS
Carbide and Carbon Chemicals Corporation

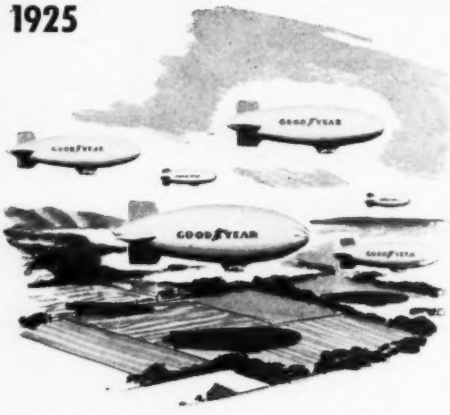
ELECTRODES, CARBONS AND BATTERIES
National Carbon Company, Inc.

INDUSTRIAL GASES AND CARBIDE
The Linde Air Products Company
The Oxweld Railroad Service Company
The Prest-O-Lite Company, Inc.

PLASTICS
Bakelite Corporation
Plastics Division of Carbide and Carbon Chemicals Corporation

Trail Blazing in the Skies

1925



THE LARGEST COMMERCIAL NON-RIGID AIRSHIP FLEET in the world was built and flown by Goodyear in the interval between World Wars I and II. Beginning with the launching of the airship Pilgrim in 1925, no less than twelve airships have flown the Goodyear flag from eight operational bases, located from coast to coast. These ships flew a total of 4,000,000 miles without a single mishap, providing a great increase of knowledge regarding air structure, meteorology and airship engineering that has been of inestimable value to the nation in wartime lighter-than-air operations.

1943

THE LARGEST NON-RIGID AIRSHIP EVER BUILT is the new M-1, recently completed by Goodyear Aircraft for the United States Navy. Approximately 50% larger than the Goodyear-built airships now so effectively protecting America's coastal sea lanes, the M-1's wider cruising range and greater bomb-load capacity make it a more effective member of the anti-submarine team. Distinctive feature of the M-1 is its three-unit, articulated control cabin that distributes its weight over a larger area of the envelope — a novel application developed by Goodyear Aircraft out of its long experience in lighter-than-air design.

HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE AIRCRAFT INDUSTRY

1. By *constructing subassemblies to manufacturers' specifications.*
2. By *designing parts for all types of airplanes.*
3. By *re-engineering parts for mass production.*
4. By *extending our research facilities to aid the solution of any design or engineering problem.*
5. By *building complete airplanes and airships.*

BUY WAR BONDS to Speed Victory

GOODYEAR AIRCRAFT

Loren Smith from Black Star

Liberty ships in an outfitting basin

VOLUME 46 NUMBER 3

THE TECHNOLOGY REVIEW

TITLE REGISTERED U. S. PATENT OFFICE

EDITED

AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CONTENTS for JANUARY, 1944

THE COVER — RUBBER PLANTATION: AMERICAN STYLE

Distilling section of a butadiene plant. From a photograph for the Neches Butane Products Company

ANGLE — FRONTISPIECE — 132

THE ANCIENTS HAD A BATTERY FOR IT — BY DAVID O. WOODBURY — 134

AVIATION AFTER THE WAR — BY S. PAUL JOHNSTON — 137
Airy Utopias Are Likely to Remain Just That for Some Years

MEET TARSIUS — BY M. F. ASHLEY MONTAGU — 139
Man's Most Distant Ancestor

CONVERSION AND THE CONFEDERACY — BY GEORGE FORT MILTON — 141
In the Production of Munitions the South Scored a Success

FABRICS OF OUR FATHERS — BY EDWARD R. SCHWARZ — 143
Language Records the Linking of Cloth with Civilization

RECOLLECTIONS OF THOMAS A. WATSON — BY MERTON L. EMERSON — 146

☆ ☆ ☆

THE TABULAR VIEW — 126
Contributors and Contributions

MAIL RETURNS — 128
Letters from Review Readers

THE TREND OF AFFAIRS — 133
News of Science and Engineering

THE INSTITUTE GAZETTE — 145
Relating to the Massachusetts Institute of Technology

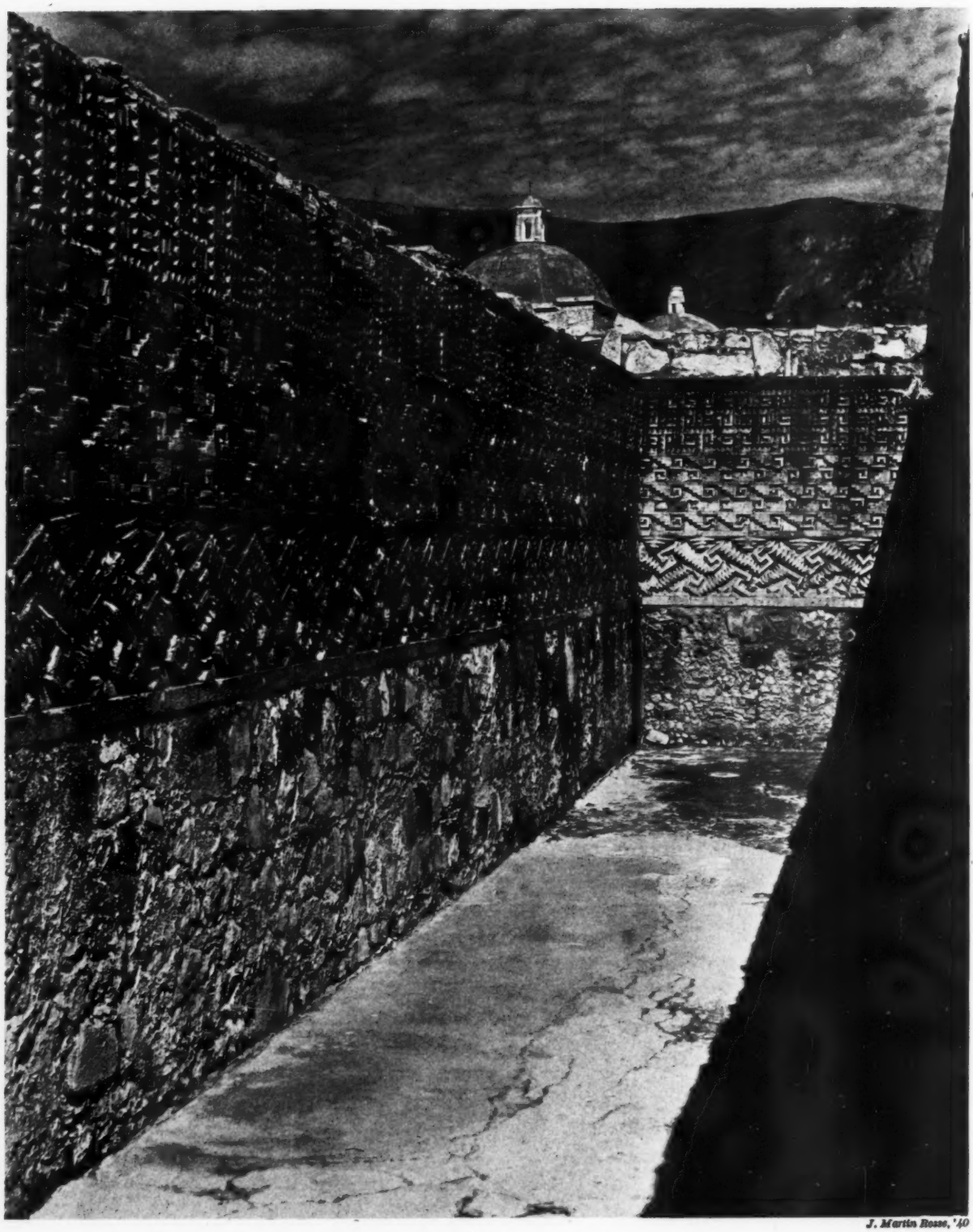
Published monthly from November to July inclusive on the twenty-seventh of the month preceding the date of issue, at 50 cents a copy. Annual subscription, $3.50; Canadian and foreign subscription, $4.00. Published for the Alumni Association of the M.I.T.: Francis J. Chesterman, President; Edwin D. Ryer, Raymond H. Blanchard, Vice-presidents; Charles E Locke, Secretary; Ralph T. Jope, Treasurer. Published at the Rumford Press, 10 Ferry Street, Concord, N. H. Editorial Office, Room 3-219, Massachusetts Institute of Technology, Cambridge 39, Mass. Entered as second-class mail matter at the post office at Concord, N. H. Copyright, 1943, by the Alumni Association of the Massachusetts Institute of Technology. Three weeks must be allowed to effect changes of address, for which both old and new addresses should be given.

Publisher · H. E. LOBDELL *Editor* · F. G. FASSETT, JR. *Business Manager* · R. T. JOPE

Editorial Associates

J. E. BURCHARD PAUL COHEN J. R. KILLIAN, JR. P. M. MORSE
J. J. ROWLANDS E. R. SCHWARZ

Staff { *Editorial:* JANE MCMASTERS, MIRIAM GOSIAN
Business: MADELINE MCCORMICK, RUTH KING



J. Martin Rosse, '40

ANGLE

Ruins of the Priests' Palace in the ancient town of Mitla in the state of Oaxaca, Mexico

THE
TECHNOLOGY
REVIEW

Vol. 46, No. 3 January, 1944

The Trend of Affairs

Backward Glances Ahead

MARCH the 21st is possibly the most significant politically of the backward glances which lie before us in 1944. It was 90 years ago that day that Commodore Perry concluded with a self-styled tycoon the treaty which brought Japan into contact and commerce with the Western world. The record of the sons of the cherry blossom over the decades since will ring a few jangling bells during 1944: July 23, 1894, Japan seized the palace and the king of Korea, starting a war with China; February 8, 1904, Japan went to war with Russia; August 23, 1914, Japan went to war with Germany. As history hath it, the mikado's undertaking against the Chinese in 1894 grew out of the Japanese conviction that a military success was essential to the recognition of Japan as a power by the Occident. Henry Pu-Yi, who became emperor of Manchukuo on March 1, 1934, as a by-product of the most recent of these endeavors to show the world, had abdicated in 1912 the throne which the Manchu dynasty had established at Peking in 1644.

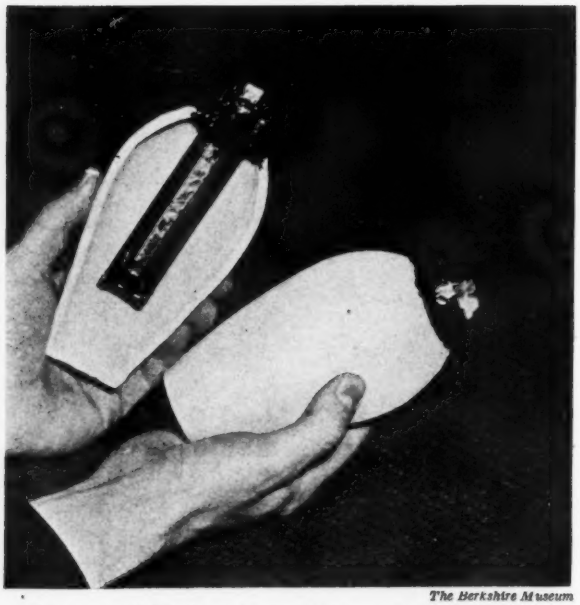
It was of course on August 4 thirty years ago that Great Britain made good her word again by declaration of war on Germany the day following the kaiser's action against France and Belgium. That year saw the one-hundredth anniversary of the Treaty of Ghent, December 24, 1814, establishing a peace between the two great English-speaking nations which in this its 130th year is a greater bond than ever.

To turn from wars, many of the 366 days of 1944 will be signalized for happier reasons. Among them are April 25, date of the first two-way telephone conversation around the world, when Walter S. Gifford spoke with T. G. Miller in a near-by room in New York, the call being routed through San Francisco, Java, Amsterdam, London, and back to New York, 1934; August 15, opening of the Panama Canal, 1914; May 6, organization of an American company by Cyrus W. Field to finance the laying of an Atlantic telegraph cable, 1854; May 24, completion of the first telegraph line by Samuel F. B. Morse, Washington to Baltimore, over which the first telegraphed news dispatch traveled the next day, 1844; June 15, patenting of his process for the vulcanization of rubber by Charles Goodyear, 1844.

Less narrowly defined are other anniversaries ahead. The idea of the military tank dates from 1914. To that year also are assigned by some annalists Brearley's development of stainless steel and Bergius' process for the manufacture of gasoline by liquefaction of coal. Ten years before, in 1904, J. A. Fleming constructed a practical electron tube. The year 1884 saw the first patenting of the linotype by Ottmar Mergenthaler and the commercial manufacture of the practical fountain pen invented by L. E. Waterman. Charles Parsons' steam turbine likewise dates from that year. Forty years before that, Uriah Boyden developed the first successful water turbine, in 1844, when John Mercer devised the treatment of cotton known by his name.

In 1804, Colonel John Stevens and his son Robert built and operated in New York Harbor an experimental twin-screw steam launch, the *Little Juliana*. Richard Trevithick in England had put steam to work that year in the first steam locomotive to run on rails. Twenty years earlier, 1784 was marked by the exhibition of a small experimental steamboat in Virginia by James Rumsey and by the appearance of the first American daily newspaper, the *Pennsylvania Packet and Daily Advertiser*, at Philadelphia. In the century before, Von Guericke's development of the air pump for the production of vacuum was accomplished in 1654.

In the world of ideas, 1774 is memorable for Priestley's discovery of dephlogisticated air — oxygen — and other gases; 1684 for Leibnitz' publication of his method of differential calculus. Of the numerous noteworthy birth years which will become another decade distant during 1944, the year 1564 is by far the most memorable: Art and science both owe it much, for it was the natal year



The Berkshire Museum

This is a model built to the specifications of mysterious vessels dating from some 2,000 years ago. With copper sulphate as an electrolyte, duplicates of the ancient device operate perfectly as galvanic batteries.

of William Shakespeare and Galileo Galilei. Physics and chemistry in 1944 will note the 120th anniversaries of Lord Kelvin, Wilhelm Hittorf, and Gustav Kirchhoff, all born in 1824.

Among the historical oddments which 1944 prompts remarking are that the first American newspaper advertisement appeared in the Boston *News-Letter* in May of 1704; that Lewis and Clark began their ascent of the Missouri on their memorable expedition to the Pacific in May, 1804; that head lamps became standard equipment on automobiles in 1904, and that the inclusion of bumpers as standard equipment came 20 years later.

As concluding item for this avowedly cursory catalogue, there is interest in the fact that the first trans-Pacific airplane flight, on May 16, 1924, was from Attu Island to Paramushira Island, and that it was made by three United States Army fliers.

The Ancients Had a Battery for It

BY DAVID O. WOODBURY

IN a glass case in the Egyptian room of the Berkshire Museum at Pittsfield, Mass., there rests a strange little object made of pottery and metal which may change the whole concept of the birth of voltaic electricity. It is a modern replica of an electrolytic cell discovered a few years ago in the ruins near Bagdad. The find was made by Wilhelm König of the Iraq Museum. In the course of excavations in Khujut Rabu'a, southeast of the present city, the mysterious little vessel was brought to light in the summer of 1936. At that time its significance was not understood.

The pottery jar was about six inches high. Inside it was a copper cylinder closed at the bottom with a soldered plate. Within this were the remains of an iron rod, eaten down to a point at its lower end. Traces of asphalt around the neck indicated that the two metals had been supported concentrically but insulated from each other.

While the mystery was in debate among the museum's scientists, four more similar jars were discovered at the excavations at Tel'Omar. Three of these proved to have the same kind of copper cylinder, though no iron electrodes were present. Iron and bronze strips were found near by, however, suggesting wires used to complete an electric circuit.

In 1938 the data and drawings of the ancient device were brought to Germany, and there they soon disappeared into the maelstrom of approaching war. Not, however, before several conjectural articles had been published in the technical press. Consensus was that the relics were an ancient form of the galvanic battery devised by Volta. The period assigned was some 2,000 years before the Italian professor made his invention.

Though the matter must remain pure speculation, the circumstantial evidence is rather complete. Dr. König was authority for the statement that there still exists in modern Bagdad a primitive art of electroplating with zinc, the origin of which is obscure. Numerous examples of ancient Parthian bowls and vases of copper, plated with gold and silver, are also to be found. No one has ever before discovered how the plating was done. Since one metal can most easily be deposited upon another, especially a dissimilar one, by electric current, it is a fair assumption that the ancients not only knew of electricity but understood how to make it and use it. The question of a suitable electrolyte would not have been difficult. Both acids and alkalis were probably then known.

Not long ago a German scientific writer, Willy Ley, brought to America the few facts concerning this important discovery. They interested him so much that he concocted around them a fictional story which was published in *Astounding Stories* in 1939 and subsequently picked up by various trade journals and digest magazines. In the meantime a London field museum party uncovered 12 more of the little pottery cells on the same site. Still others were unearthed at Ktesiphon soon after by scientists of the State Museum of Berlin. Since the latter cells were found with a number of objects of the Sassanian period, to date them back at least to the time of Christ seems reasonable. Further research may establish an even greater antiquity, for the ancients of that region are known to have plated objects with gold and silver as long as 4,000 years ago.

Dr. Ley's story came to the attention of Willard F. M. Gray, an electrical engineer at the General Electric plant in Pittsfield. Mr. Gray was so much impressed that he obtained all the data from Dr. Ley and, curious to see whether an ancient battery of this sort could have worked, built an exact duplicate. Using copper sulphate as an electrolyte, he found that the cell operated perfectly.

There the investigation rests at the moment. When the war is over, several museums will undoubtedly return to the site for further exploration, perhaps hoping to discover a whole electroplating unit intact.

If they do, what then? To know that the ancients used electricity will give us one more link in the chain of evidence that our much vaunted modern civilization is not quite so original as it thinks. A safer supposition is that in any age the people will be ingenious enough to provide themselves with the means essential to living a satisfactory life.

Power the Hard Way

THE Navy," says Rear Admiral Earle W. Mills, "believes that the gas turbine will be of great importance as a main propulsion drive in the future and is actively engaged in its development. . . ." Similar professions of faith are beginning to abound in the literature on the gas turbine, as well they might, for the prospects for this power producer, long based on theory, are now bolstered by a small but impressive list of successful applications. A locomotive driven by a 2,200-horsepower gas turbine is demonstrating its capabilities in Switzerland. A 4,000-kilowatt gas turbine unit has been delivered as stand-by capacity for the power system of the Swiss city of Neuchâtel. Gas turbine units with outputs in the thousands of horsepower have been running almost continuously for the past several years in certain American and foreign oil refining plants where large quantities of compressed air are needed to regenerate the catalysts by burning off the carbon which collects on them. The hot gases resulting from the combustion are used to drive the gas turbines, which not only drive the compressors but also furnish sizable amounts of power.

As far as total capacity is concerned, however, the most important immediate application of the gas turbine is in the superchargers of high-altitude airplane engines. Every Thunderbolt carries one of these gas turbines, every Lightning two, every Flying Fortress and Liberator four. Because of the great incentives involved, this application has spurred research on all phases of gas turbine and compressor design, and has demonstrated that the latest alloy steels can withstand, at least for limited periods, temperatures hundreds of degrees higher than is present steam turbine practice.

That the gas turbine retains the grip on the imagination of engineers which it has held for the past 150 years, most of them years of failure and frustration, was demonstrated in New York recently when C. Richard Soderberg, Professor of Mechanical Engineering at the Institute, and Ronald B. Smith, director of research and development of the Elliott Company, presented a paper on its possibilities as a marine prime mover. The group of naval officers, ship designers, and engineers who attended this session of the Society of Naval Architects and Marine Engineers filled every seat and stood in ranks along the walls. "Much of the available literature on gas turbines," said the authors, "has been premised on low efficiency. This defeatist attitude has developed to such a degree that it is now generally held that within the temperature limits of our available engineering materials it is impossible to produce a plant comparable in efficiency with existing prime movers. The prevalence of this misconception is unfortunate, and the authors wish . . . to take an emphatic stand against it."

The great virtue of the gas turbine is simplicity. As prime movers go, it has few components; it is cheap to build; it is light, potentially lighter than any other form of engine except an out-and-out rocket or jet propulsion engine. Provided the limitations of its materials are not exceeded, it is expected to have the reliability, long life, and low lubricating-oil consumption which are characteristic of the turbine class of machinery. Until recently, however, most attempts to exploit these advantages have foundered on the rock of low efficiency. Thermodynamically, the gas turbine is a hot-air engine. Air under moderate pressure, generally lower than 100 pounds a square inch and often much lower, is used to burn a suitable fuel. The energy in the hot gases of combustion is then drawn on by the direct but hard way of their being passed through a turbine, the nozzles and buckets of which are thus exposed to the heat and corrosive action of the gases. In order to cool these gases to a level fixed by properties of the available materials, a large excess of compressed air is injected into the combustion chamber, which lowers the thermal efficiency of the turbine and increases the load on the compressor. Driving this compressor is the turbine's first job, and the difference between the output of the turbine and the power absorbed by the compressor is substantially the net, or useful, power. A good present-day turbine might deliver 600 horsepower to the compressor for every 400 horsepower of net output.

Because the useful power is a difference, it is exceptionally sensitive to the efficiencies of the components in the cycle. For many years the difference was virtually zero, and the best that inventors could do was to build a plant that barely turned itself over. Progress in metallurgy and in the art of building rotary compressors has been mainly responsible for improving that situation. The gas turbine, because it rotates continuously and at high speed, demands some rotary form of compressor, of which there were no efficient types in the Nineteenth Century and the early years of the Twentieth. Today the

Ted Watterson

By way of contrast with the reminders of ancient science opposite, here is vivid demonstration of the scope of a modern project unfinished — a truck hoisted into the dome of the observatory on Mount Palomar, where completion of the 200-inch telescope awaits return of peace.

designer can choose from several forms with efficiencies over 80 per cent. Moreover, the multistage axial-flow compressor has exceeded efficiencies of 83 per cent.

Even more important in broadening the scope of the gas turbine has been progress in high-temperature steels, for as the inlet temperature goes up, less cooling air is needed and the turbine can extract more energy from every pound of gas passing through it. The difference grows from both ends, so to speak, and over-all efficiency may rise twice as fast as does the temperature. In the gas turbine locomotive previously mentioned, a thermal efficiency of about 18 per cent at three-quarters of full load was obtained. But the engine was built in Switzerland during the present war, and the difficulty of obtaining high-alloy steels (a factor hindering the gas turbine program in this country also) restricted the inlet temperature to 1,112 degrees F. Had the inlet temperature been 1,500 degrees F., it is estimated that the thermal efficiency would have been almost doubled. Soderberg and Smith believe that thermal efficiencies of 30 per cent or more are immediately attainable with gas turbines operating at inlet temperatures of about 1,200 degrees F. With present materials, such turbines should show the same degree of reliability as existing steam turbines operating at 900 degrees F. If and as the gas turbine becomes capable of operating on the cheaper fuels, it may well become a competitor of the Diesel and steam turbine even for base load power.

That a temperature of 1,200 degrees F. is a conservative design figure is shown by the performance of gas turbine superchargers which must operate for long periods on exhaust gases ranging in temperature from 1,200 to 1,700 degrees F., with 1,500 degrees widely quoted as an average figure. Most parts of a turbine of course operate at levels considerably below the inlet temperature; nevertheless, the use of metals under such conditions may be compared, in Soderberg and Smith's words, "to the shifting to a brittle material like cast iron for the buckets and rotors of conventional turbines at lower temperatures."

In contrast to the mutation which, like the incandescent lamp, goes virtually in one jump from the laboratory to commercial success, the gas turbine can serve as an almost classic example of the type of technical evolution that proceeds so slowly and by such small steps that, when practical forms of importance are finally achieved, engineers can't quite believe it. Time was when only calculations separated the gas turbine from the class of perpetual-motion devices. Recently, Professor Jerome C. Hunsaker, '12, declared that the gas turbine was one of the three reasonably possible developments which might radically and rapidly change standards of airplane performance. The reciprocating engine has for a long time clung to the plateau of roughly one pound of weight per horsepower. The gas turbine offers hope for a considerably lighter engine. In marine and rail transportation also, the gas turbine offers the possibility of replacing complex and highly developed engines with mechanisms that are light, cheap, simple — and hard to design. The metals and compressors that have made possible the present stage of the gas turbines are available for use in other prime movers, but for various reasons the others do not stand to gain as much relatively as has the gas turbine. The old order changeth, yielding place to new.

The Institute made preparations nearly two years ago to do its proper share in assisting that change, through the naming of a committee by Edward L. Moreland, '07, Dean of Engineering, to survey the problems and possibilities presented by the gas turbine. Under the chairmanship of Professor Soderberg, the committee — comprising John Chipman, Professor of Process Metallurgy; Hoyt C. Hottel, '24, Professor of Fuel Engineering and Director of the Fuels Research Laboratory; Joseph H. Keenan, '22, Professor of Mechanical Engineering; Charles W. MacGregor, Professor of Applied Mechanics; Frederick H. Norton, '18, Professor of Ceramics; and Edward S. Taylor, '24, Professor of Aircraft Engines — resolved the fundamental problem into a group of component questions. Subsequently, the committee has become a joint interdepartmental one under the chairmanship of Professor Hunsaker, with Professor Soderberg as vice-chairman and Dean Moreland or Robert S. Williams, '02, Deputy Dean of Engineering, serving ex officio as member. Thus far, the combustion problem has been the main focus of study, and considerable progress has been made on various phases of it. Analytical studies of turbine cycles, of compressors and turbines, and of fracture, fatigue, and creep of materials constitute other phases of the work projected. It is anticipated that as war demands lessen, constantly increasing effort will be applied to the vigorous prosecution of a program of co-ordinated research in the field.

Plague in the United States

TO most people, the plague seems one of those terrible diseases of distant countries which we never expect to encounter if we stay at home. It seems to come as rather a shock that plague has occurred regularly in the United States for more than 40 years. It has been continuously present since 1900 in western United States, and the evidence is that it is not merely going to remain with us but is going to spread more and more. In the early years of this century (1900–1908), nearly 300 cases appeared in the area around San Francisco and a few others elsewhere along the Pacific Coast. It did not begin to spread eastward, however, until about 1930. Fortunately, no serious outbreaks have occurred for a good many years, though there was one in Los Angeles in 1924. In view of these relatively rare occurrences in man, how can we say that the plague will remain with us?

Plague involves four sets of living organisms: man, whom we think of as the important victim of the disease; a bacillus (*Pasteurella pestis*) which actually causes the disease; various rodents which, like man, are victims of the disease and which keep it going outside of man, and, finally, an assortment of fleas which carry the bacillus from one victim to the next.

It is clear, then, that if plague is present in rodents (we call it "sylvatic plague"), it always stands a chance of being passed on to man. The United States Public Health Service traps wild rodents extensively and tests both the rodents and the fleas for infection with plague. As a result of the health service's work, we know that plague is present very extensively in coastal California from San Francisco to Los Angeles; less extensively in extreme northern California, northeastern Oregon, and southwestern Montana; and, more scatteringly, in all the states west of the eastern (*Continued on page 166*)

Aviation After the War

Airy Utopias, Objectively Scrutinized, Are Found Likely to Remain Just That for Some Years

By S. Paul Johnston

The term "postwar" is very loose. It can mean almost anything. What most of us mean, however, is the immediate future, the first few years after the final windup of the present war. Five to ten years would be a reasonable figure. In the discussion which follows, that is what will be meant by the "postwar era." The probable developments of the first five years can be predicted quite accurately. The trends for the second are already discernible. — S. P. J.

ADVERTISING copy writers, Sunday supplement artists, and the long-whiskered prophets of the science-made-easy school have handed the people of America a magnificent Easter egg — one of those sugar-decorated shells in which they can peer at a pasteboard fairyland. Inside is pictured the dreamworld of tomorrow — glass and plastic houses, superspeed elevated highways, skies full of aircraft. With eye glued to the glass, many regard this Futurama as close enough to grasp.

It is quite possible that the cities of the future will look like the World's Fair concept of 1939. Automobiles of the future *may* look like torpedo-shaped projectiles. Aircraft of the future *may* look like Buck Rogers' space ships,

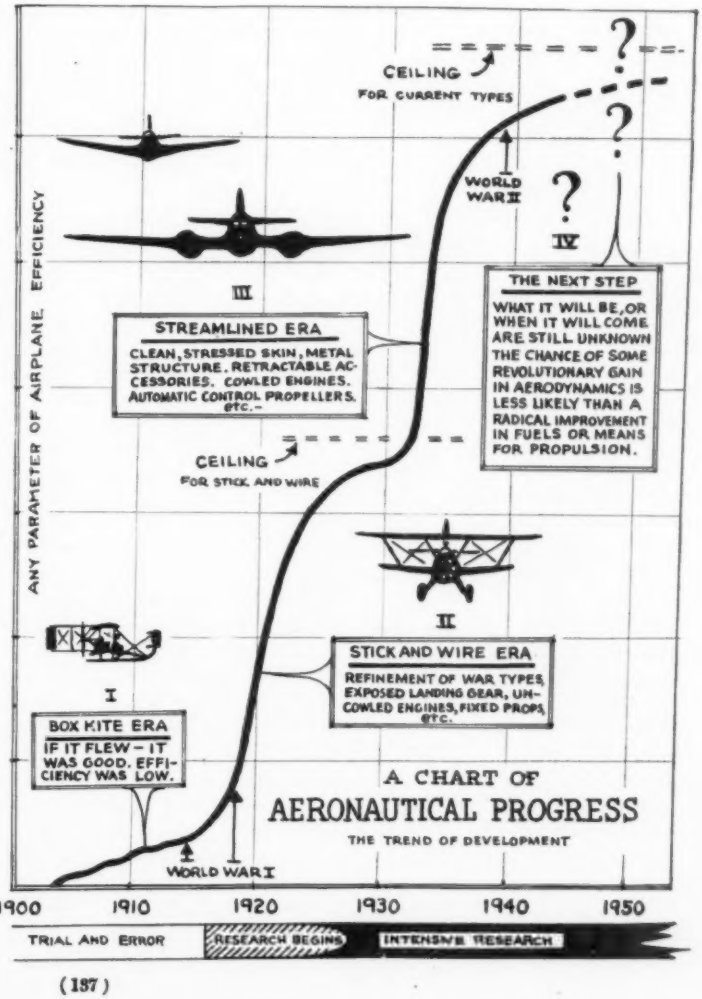
But —

Those of us who survive the present war with an expectation of seeing for ourselves the events and the changes of the next ten or a dozen years had better back away from the peephole and take a look at the things that lie between us and the Promised Land. It may not be quite so near as it seems.

We are now experiencing a throwback into a Victorian state of mind. In the late 1800's, when scientific development had approached a point where flight for man seemed within reach, the wildest sorts of imaginings were committed to paper. Voyages to the moon and other journeyings into interstellar space became common subjects for drawing room conversation. But after the Wrights, Curtiss, and other practical men had demonstrated to the world that flight was actually possible, the average man accepted the airplane with reservations. "It ain't safe!" was common comment. Even by 1918 the airplane had not established itself as a practical vehicle. Few people looked upon it as anything but a new and exciting kind of military plaything which required more heroism than good sense to manipulate.

Now, the airplane has proved its value as a peacetime carrier of commerce as well as a weapon of war. Aviation has ceased to be a game. It has outgrown the emotional instability of adolescence and has emerged as a new and completely practical mode of transportation. It is destined to play a tremendously important part in our postwar world.

But curiously enough, intermingled with today's hard-headed business and engineering approach, popular imagination is again tending to outrun probabilities. Many people seem to believe that a great and new discovery will spring full-blown from the brain of some genius to lift the level of aviation's possibilities far beyond present limits. This may well be so, but it is far safer to assume that aviation will continue to grow and to develop along now familiar lines. New designs and improvements are definitely in sight. At the moment, however, no magic formula is in evidence, no "Open sesame" has yet been spoken to swing wide the doors to a dreamworld. To the layman, the practical ceilings that are clearly discernible



to the aerodynamicist and to the engineer simply do not exist. Once again we are off for the moon.

In that fantastic World of Tomorrow which many believe will emerge at the coming of peace, the skies are black with layer upon layer of strange aircraft. At the lower levels, the commuter goes to work, the milkman delivers milk, and the newsboy drops the morning paper on the doorstep by helicopter. Higher up, interurban helicopter busses filled with shoppers and sight-seers pinwheel back and forth. On other levels, batlike planes shuttle between distant cities, and glider trains shift their loads in aerial switchyards. Highest of all, the stratosphere liners, spouting flame and smoke from rocket engines, roar on services transcontinental and transoceanic.

To the layman in aeronautics such things seem quite plausible. He has read all about them in the papers. He has been well fed on the manna showered down by the glamour boys. For example, this from a recent Sunday magazine article:

> *Vacation, 1950:* Your bag is packed . . . you step . . . into your helicopter, you start the motor and the windmill overhead lifts you into the air. You fly over to the airport, park the helicopter, buy your ticket, and get aboard the commercial plane. . . . But what a plane! Accommodating 200 passengers . . . it might be a metal reproduction of some flying reptile of the age of dinosaurs. . . . Commodious, luxurious quarters, comfortable lounge chairs, a restaurant and observation cabin. . . . No more "street car" seating arrangements. . . . *This is how you will fly after the war.* . . .

Or this from a broadside of a famous news magazine:

> Dear American:
>
> Are you keen to see the wonders of the postwar world? Are you interested in an America where . . . you can catch a helicopter taxicab, pilot your own Ford of the air . . . fly in luxury from New York to London for a hundred dollars? . . .

the promise being implicit that you will read of all these things before your subscription expires!

A dozen more samples could be culled from the editorial or advertising pages of almost any magazine. Such postwar scenes are exciting. The idea of a helicopter in every garage has a definite appeal. And who would not like to picture himself comfortably ensconced in a flying wing for a quick visit to London at a hundred dollars a head? These *may* be postwar pictures, but more likely they are *post* the *next* war. Unless the present conflict lasts much longer than we think, immediate postwar years are far more likely to resemble the immediate pre-war years than they are the fantastic picture just outlined.

The reasoning is not hard to follow.

Take any parameter of aviation progress which comes to mind — aircraft efficiency, utility, or what not — and sketch a curve against a time scale, as in the chart on page 137. From first flight (1903) to about 1915, improvement was slow and irregular. World War I touched off a skyrocket rise in the curve, which persisted with minor variations into the late Twenties. Then a ceiling was approached. There was just so much "in the wood" for the then basic type. Thin-winged biplanes with exposed bracing could go only so fast. There was too much drag in struts and wire. Fabric wing covers would not stand the gaff. Openwork engines and fixed-pitch propellers reached a limit in over-all effectiveness.

As a direct result of the application of research, the stick and wire multiplane gave way almost overnight to the much more efficient stressed-skin, highly streamlined monoplane that is in universal use today. The completely cowled engine, coupled through reduction gears to a slow-turning, controllable-pitch propeller, yielded propulsive efficiencies unattainable before. Power-consuming drag was reduced to a practical minimum by the elimination of wires and all other excrescences. Landing gears were folded away when not in use. Landing lights and other exposed gadgets were built into wing or fuselage contours, or were made retractable in flight. Junctions of wing and tail surfaces with fuselage were studied carefully and filleted to induce smooth air flow and to reduce interference drag. Even the rivet heads that originally pimpled the skin of the early all-metal planes were lopped off to make surfaces as smooth as practicable. Wing flaps and other so-called high-lift devices permitted increases in wing loading to be made with safety that had been undreamed of.

The cumulative effect of all these things tore a hole in the ceiling of the late Twenties and bent the rate of progress curve sharply upward.

Presently other limiting physical factors began to be felt. A new ceiling was in sight. Wing loadings, even with the best of the known lift-augmenting devices, shortly reached a point where safety again became marginal. Limitations in controllability became apparent. On the structural side, the best of the aluminum, magnesium, and steel alloys known to metallurgy can safely be stressed only so far. The best of the fuels and oils known to the chemical sciences will produce just so much energy or will withstand just so much friction load without breakdown in engines as we know them today. And for some reason not yet entirely clear, most aerodynamic phenomena reach a critical point at speeds approaching the velocity of sound, about 750 miles an hour. Once past that point, smooth air flow, on which the lift of wings and the bite of propellers depend, breaks down and a violent turbulence develops which may wrench the strongest plane to bits in a few seconds with explosive force.

Of course, no airplane today is flown at anywhere near the speed of sound, except possibly in a full power dive in the hands of a test pilot. The best pre-war racer did about 440 miles an hour in level flight. Some current pursuit planes can do better than that at extremely high altitudes. Five hundred miles an hour will be possible before long, but that speed will probably be "tops" for quite a while. The catch lies in the fact that the actual velocity of air flow over certain parts of an airplane in flight may be much greater than the speed of the plane itself. Propeller tips are good examples. At the leading edges of wings and over the tops of windshields, air speeds are also likely to be extremely high. Once the speed of sound has been exceeded, even locally, strange things begin to happen. So-called shock waves, followed by a compressibility "burble," may develop, which upset all calculations and which tend to tear things apart.

Such phenomena impose a wholly new set of ceilings on airplane design. As an airplane becomes more and more efficient, the rate-of-progress curve tends to flatten out. A regime of diminishing returns sets in. Tremendous effort yields small gain. In the years when the curve was pitched steeply upward, a relatively short time interval yielded relatively great advance. Now, for the same time interval, despite expenditure of tremendous effort the increment of advance is small. It will become progressively smaller until something (*Continued on page 150*)

Meet Tarsius

Man's Most Distant Ancestor, Distinguished Genealogically, Is Interesting Personally

By M. F. Ashley Montagu

John E. Eckman

AMONG the most interesting, and undoubtedly least known, members of the order of mammals to which man belongs — the Primates — are the tarsiers. Tarsius, so called because of the strikingly elongated tarsal bones of its feet, is little known for a variety of reasons: In the first place, it is often regarded as an exceedingly rare creature even by the natives who live in the regions where it occurs, namely, in Sumatra, Java, Bangka, Billiton, Borneo, Celebes, Salayar, Sangir, Bohol, and Mindanao. (This rather restricted distribution of Tarsius is in itself rather interesting: Observe that it lies between the 110th and 130th degrees of longitude, 18 degrees to the north and 10 degrees to the south of the equator.) In the second place, in many of the localities where it occurs, Tarsius is looked upon with superstitious reverence by the natives, so that they are not anxious to capture specimens. In the third place, Tarsius is a nocturnal animal, sleeping during the day and becoming active only at night; hence expeditions made during the night are alone likely to be successful in getting a sight of the animal, and such expeditions are not relished by the natives. In the fourth place, tarsiers when taken alive have not done very well in captivity, for they are very delicate little creatures; in fact, until very recently those examples that have become known to zoologists have been dead specimens immersed, often for many years, in a preservative fluid.

You have no doubt seen a rat after it has been immersed in water; well, that is what Tarsius has looked like to most zoologists — like nothing more than a drowned rat. It is for this reason, I suspect, that the creature is so often described in the textbooks as being about the size of a small rat. Actually, except for size, the living tarsier has not the slightest resemblance to a small rat. The photographs accompanying this article will give you a better idea of Tarsius than any description could. The examples shown in these photographs are fully adult living ones which were captured for and kept by John E. Eckman while he was living in Mindanao in the Philippines. Mr. Eckman was good enough to obtain four of these little creatures for my anatomical studies. The first living specimens to reach this continent since Eocene times, a mature female and a young male, were brought to this country by Mr. Eckman in 1938 and were flown to New Haven. These two tarsiers, possibly mother and son, have thrived under the sympathetic care of Professor John F. Fulton and his colleagues of the physiological laboratory at Yale University. In due course the observations which have been made upon these little-known animals will fill one more large lacuna in our knowledge of man's relatives.

The structural characteristics of Tarsius are so peculiar that systematists have classified it in a suborder all by itself among the Primates, the Tarsioidea — the first of the primate suborders being the Lemuroidea, and the third the Pithecoidea, which includes the Old World and New World monkeys, the anthropoid apes, and man.

The tarsiers are represented by a single living genus, Tarsius, and although some seven different species are supposed to exist, we know so little about the genus as a whole that it is at present quite impossible to say whether there exist any more than the single species familiar to zoologists, namely, *Tarsius spectrum*, or the spectral tarsier (spectral because it has such huge eyes). Some fifty million or more years ago, in Eocene times, at least 21 different genera flourished, more than half of them in North America. These fossil genera, comprising the single family Anaptomorphidae, are known from European as well as from American deposits; recent studies have shown that the existing tarsiers have survived to the present time with very little structural change. For this reason Tarsius has justly been called a living fossil and probably the oldest mammal now inhabiting the earth.

Reader, look upon him with the respect he deserves; while you as a member of the human species may be able to trace your ancestry back a million and a half years, Tarsius by the most conservative estimate can trace his ancestry back at least fifty million years! But there is a still more pertinent reason why Tarsius deserves our respect: Scientists are generally agreed that among primates he stands as the most distant ancestor in the direct line of man's descent. In spite of superficial appearances, the resemblances of Tarsius to man are very striking, so much so that one distinguished authority, Professor Wood Jones, has gone so far as to claim that in the line of direct descent, Tarsius is more closely related to man than are any of the great apes. Other students of the subject, however, do not accept this view but believe instead that all the evidence strongly suggests that Tarsius represents one of the earliest, if not the earliest, of primate forms. The mammals most closely resembling the primates that are generally agreed to stand at the base of the

primate stem — the stock from which the primates sprang — are the tree shrews (Tupaiidae) of the order Insectivora. They so closely resemble primates that some systematists and morphologists have actually brought them into the order of Primates, which fact shows how narrow the border may be between one order and another. However this may be, there is no doubt that the tree shrews are very closely related to Tarsius not only structurally but in their behavior and habits as well. Thus, the tree shrews are almost exclusively insecteaters and so too are the tarsiers. Another interesting likeness between them is that the fossil and the living members of both groups have much the same geographic distribution. In the geologic time scale, tree shrews appear before tarsiers, namely, in the Cretaceous period of the Mesozoic era, and thus in every way they make excellent ancestors for the tarsiers. Tarsius, therefore, would appear to enjoy the honor of being that form in the animal kingdom which remains as the living link between the nonprimate mammals and the primates. It is a very distinguished position to occupy on the genealogical tree, and for this reason, as for the qualities which have enabled it to survive so long, Tarsius deserves to be better known and honored.

A fully grown tarsier measures about four to five inches (excluding the tail) and weighs about seven ounces. It is therefore the smallest of the primates. The scantily covered, rather ratlike nonprehensile tail is tufted at the tip, but the hair on the rest of the body is quite thick and is a gray brown in color, the tip of each hair being reddish brown and the base being blue gray. The somewhat batlike ears are bare on the inner surface and almost bare on the outer surface, while the skin on the inner side has a number of crisscrossing, wavelike folds. The function of these folds is at present not understood; though they may have something to do with picking up sound more easily, the tarsier's sense of hearing is not known to be particularly acute. More probably they are related to the animal's ability to fold the upper part of its ears in such a manner as to reduce their area considerably and bring them close to the side of the head. When the animal is listening intently, the ears are widely opened and are moved back and forth, one pointing to the front and one to the rear, alternately.

The most striking thing about the tarsier is its huge eyes. The sockets giving support to the eyeballs extend laterally to such an extent that they have been described as giving the animal the appearance of wearing aviation goggles. This condition is even more true of the skull, which seems to be all orbit. The eyes, according to anatomists who have made studies of them, are capable neither of conjugate movements nor of stereoscopic vision, but at the side of the entrance of the optic nerve into the eyeball there is a slightly differentiated area which undoubtedly represents the beginning of the "blind spot" that renders stereoscopic vision possible. Tarsius is the first primate to exhibit this character.

Since Tarsius is a nocturnal animal, its vision during daytime is very poor, its pupil being reduced to a pin point. At night the pupil enlarges to such an extent that only a very narrow rim of brown iris can be seen around it. Colonel George Chase Lewis, who has kept more than one tarsier as a pet in the Philippines, says of one of them that "the eyes possessed great mobility and rolled widely sidewise and vertically in their sockets, exposing great expanses of white eyeball in the faint light in a way reminiscent of a southern pickaninny hearing a ghost story. A more weird and ghostly countenance than that of the tarsier could not be found outside of a witch's family album."

John E. Eckman

". . . A more weird and ghostly countenance than that of the tarsier could not be found outside of a witch's family album. . . ."

And ghostlike indeed is Tarsius, for those eyes of his tell perhaps the most important story that can ever be told out of the far distant past of man's beginnings. In those eyes, in their size and position — for now they are no longer on each side of the head, as in other mammals, but boldly out in front — we see the development of the dominance of the sense of sight and the retrogression of the sense of smell. Tarsius has a poor sense of smell, and his brain is no longer an olfactory but a seeing brain. The importance of this change cannot be overestimated: Once it had occurred, no longer did one have to keep one's nose to the ground in order to make a living. Changing from a terrestrial to an arboreal existence is essentially correlated with the necessity to *see* rather than to smell, for one cannot catch insects on the wing by smelling for them but only by looking for them. And when one sees them, one must be able to catch them; therefore one's forelimbs must be freed for the task.

All these important changes in the evolution of the primates can be read in Tarsius, and that is another reason why the creature deserves to be better known by all of us. Unfortunately, the tarsiers are such delicate creatures, and so rare, that it is not yet possible to exhibit them in zoological gardens. *(Concluded on page 154)*

Conversion and the Confederacy

In the Production of Munitions the South Scored a Success Despite Handicaps Dwarfing Our Recent Worries

By George Fort Milton

ACCOUNTS of the life and death of the Confederate States of America place great emphasis upon the breakdown of the economy of the seceded states, the fatuous operation of its railroads, and the ravages of an almost astronomic currency inflation. All of these, of course, are indisputably among the principal causes of the failure of the second American revolution. But they tend to obscure one extraordinarily efficient operation of Southern supply — that of munitions of war. This was outstanding, not only in contrast to the worse than indifferent handling of food procurement for the Confederate armies but even more in relation to the munitions problem itself. Aside from triumphs of the contest in arms, it represents perhaps the high point of Confederate defense achievement.

All through 1941 and in much of 1942, we Americans were talking about the difficulties of "conversion," but these difficulties were small compared to the problems which faced the South at the outset of the Civil War. The conversion we had to plan and execute in the last two years was, after all, that of an economy fundamentally industrial. We already had a frame of reference in an elaborate and efficient technological producing plant. We were disturbed by the need to adapt old tools and processes, or to contrive new plants, tools, and skills to produce great volumes of matériel for war. But the South had to make just about a total conversion to an industrial society and economy from a way of life which from the beginning had been predominantly agricultural.

The Confederate States had no such breathing spell of time as we had between Germany's invasion of Poland on September 1, 1939, and the passage of the Lend-Lease Act on March 11, 1941. At the most, the Southern revolutionaries were able to shape their plans to prepare for the looming conflict no earlier than June, 1860, when the Democratic National Convention at Baltimore split in two and Abraham Lincoln's election was foredoomed. Most of the principal fire-eaters, however, would not recognize the immediacy of the change of Federal control until Lincoln's actual election in November, which catalyzed South Carolina into leading the secession parade.

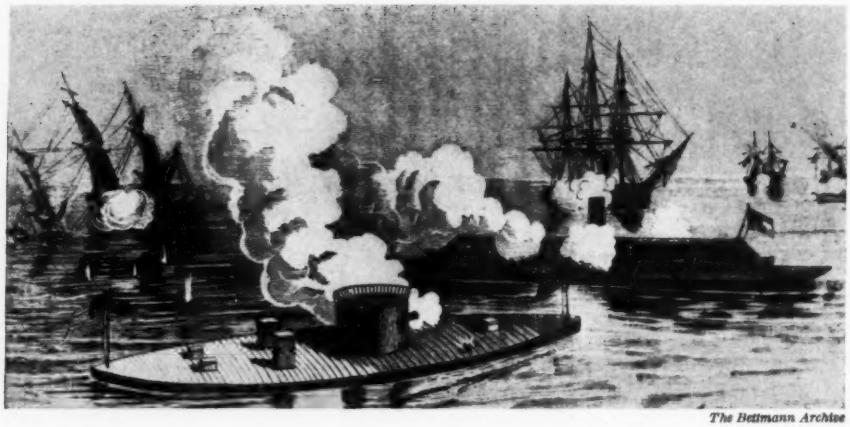
The new government was formed at Montgomery, Ala., early in February, 1861. President Jefferson Davis and his cabinet advisers clung to the illusion that what was left of the United States of America would follow the advice of the erratic Horace Greeley to let the erring sisters depart in peace. Lincoln's expedition to relieve Fort Sumter in Charleston Harbor shocked the Confederate command into the reluctant realization that independence would have to be won on the battlefield. In three months' time, secession dialectics were at heavy discount and the sword had become the arbiter.

The contrast between the economies of the antagonists was striking. The Fifties had been a period of extraordinary economic change throughout the United States. In 1850, some 22,000 miles of telegraph lines were in operation, but during the decade 38,000 miles of line were built, three-fourths of that north of the Potomac and Ohio. Of 1860's total railroad mileage of almost 31,000, the South had less than a third. New York and Pennsylvania together had invested more money in the iron horse than had the 11 Southern States.

Even more startling contrasts were presented in the field of manufactures. In the year of Lincoln's election, the North employed about 1,300,000 industrial workers, the South only 110,000. The Northern "value of annual product" figure for that year was $1,750,000,000, and that for Dixie a meager $145,000,000. There were 110,000 manufacturing establishments in the North, and only 18,000 in the South. The census takers had not found in the states soon to secede a single manufacturer of furni-

Making gun carriages in the Tredegar Iron Works near Richmond — from an old print

The Bettmann Archive



The Bettmann Archive

The first battle between ironclads: the Monitor *and the* Merrimac *engaged on March 9, 1862. Raising and reconditioning the* Merrimac *were John Mercer Brooke's first major duty as a commander in the Confederate Navy.*

ture, clothing, rubber goods, jewelry, or musical instruments.

Only 20 of the country's 206 illuminating-gas plants were in the South. The woolen industry's production had been about $69,000,000, but only about 3 per cent of it was southern. Of the boot and shoe industry's $89,000,000 output, a little more than 2 per cent was southern. Cotton might be king, but New England produced three-fourths of the cotton goods, and the South's textile plants only about one-fifteenth. In lumber, a low-skill process, the South turned out less than a fourth of the output of the Loyal States. The largest product value among the nation's industries was that of processing flour and meal. Here the Southern States were credited with $30,700,000, out of a national total of $223,000,000.

The heavy industries are always basic for the supply of actual military matériel. The South had enormous undeveloped natural resources, but her processing record was absurdly small. The best showing was in copper, in the Ducktown basin in southeastern Tennessee; in 1860, the South produced about 40 per cent of the domestic yield. A little lead was mined in Virginia. Neither zinc nor nickel was mined anywhere in the South.

Northern coal production was 140,000,000 bushels. This contrasted with 13,000,000 in the South, concentrated in Virginia, Georgia, Tennessee, and Alabama. The South had not followed the North in turning from the use of charcoal to that of coal in ironmaking. The hot-blast process had been applied to the treatment of iron ore and scrap in 1834, and anthracite soon began to replace charcoal as iron furnace fuel. But the South did not follow. This helps explain why, out of a national smelt of over 850,000 tons in 1860, only 27,000 tons of pig iron were produced in the South. Of bar and rolled iron, the South produced 24,000 tons, the North 382,000; of iron founding, the South $2,500,000 and the North $24,000,000. The locomotives used on Southern railroads were imported either from the North or from Europe. The cast-iron rail and two-thirds of the railroad roundhouse staffs came from the North.

When the war broke out, the South had only two rolling mills capable of rolling an iron rail or a ship plate. One was the soon-to-be famous Tredegar Iron Works at Richmond. The other was a plant at Nashville. After the fall of Fort Donelson in February, 1862, the Confederate authorities moved its equipment out of Federal reach, and from then until the end of the war it was shifted hither and yon over the South.

There was only one machine shop in which a steam engine could be manufactured. Not a single Southern shipyard could essay any more ambitious engine task than minor marine-engine repairs. The Confederate States had no chemical industry, and few well-equipped college laboratories. There was but a single powder works and no laboratory for making fulminate of mercury for percussion caps. Railroad repair shops were woefully inadequate. Rail manufacture was undertaken reluctantly, and before long the Confederate Government found itself forced to rob an existing road of rails in order to build a militarily essential railroad connection from Greensboro, N. C., to Danville, Va.

Such was the situation which confronted the Confederacy at the outbreak of the war. The Davis government did not realize its full gravity for some months but preferred to gamble on the theory that "cotton was king" and that the great cotton-using powers abroad would break the Union blockade to replenish their stocks of the fleecy staple. But both England and France had heavy supplies in their warehouses. Neither power challenged the blockade in a resolute fashion until it had changed from little more than Seward's paper proclamation to a surprisingly effective sea force from Hampton Roads, Va., to the Rio Grande.

Stocks of arms and ammunition on hand in United States arsenals and armories were seized by the new government. Late in 1861, efforts were made to import artillery, small arms, ammunition, and other essential matériel. But these imports by blockade-runners were "too little and too late." The Confederacy was confronted with having to improvise its own plants and to train its own skills to manufacture the essential tools of war. And there was response — not of Davis or his cabinet but of some theretofore unknown geniuses of discovery, invention, and production skill. This is not to be wondered at. More often than not, the pressure of necessity on minds of a high order leads to extraordinary results.

Perhaps the outstanding performer was Josiah Gorgas, the chief of ordnance of the Confederate Army, who showed real genius in keeping the troops supplied with arms, ammunition, and other essential material of war. Gorgas, whose ancestry was Dutch, was born in Dauphin County, Pa., in 1818. He secured appointment to West Point and was graduated in 1841, close to the top of his class. He was assigned to Army Ordnance and in 1845 was sent on a mission to (*Continued on page 156*)

Fabrics of Our Fathers

Language in Many Ways Records the Linking of Cloth with the Progress of Civilization

By Edward R. Schwarz

WHETHER it serves as a parachute in the air or to carry air itself far underground in ventilating tubes, fabric guards the safety of the aviator and the tunnelworker alike. For generations it has ministered to our comfort, appearance, and modesty until, taking for granted the presence of fabrics of all sorts, we have ceased to note the romance of their early history and of their steady development. We fail to comprehend how closely textiles have been associated with the growth of civilization. We fail to appreciate that today we are benefiting from one of the most ancient arts known to man.

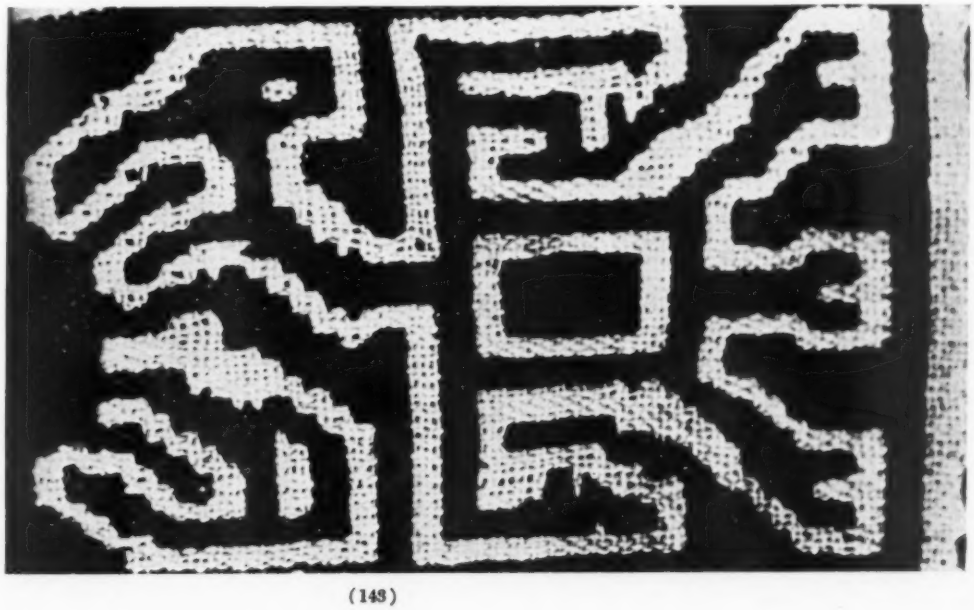
The trailing and twisting lianas of the jungle may have taught our ancestors in bygone centuries how to spin, but the art of producing a knitted fabric is mankind's achievement alone. It would be hard indeed to find in nature a woven or knitted material. Cloth, then, is one of his developments of which man may well be proud. A fabric lends itself to artistic blending of colors, as does a picture. More than this, it affords to the artist the same opportunity as does sculpture, allowing work in three dimensions. The draping qualities of fabric are unique and have been widely used to beautify both ourselves and our surroundings. This property allows the skilled user to enhance or to conceal the lines of form or figure as he wishes. A fabric is responsive to any mood of the designer, clinging or billowing according to his desire. Schools of art have been based on the rendition of fabric draping.

Fabrics are used not only as clothing but as ornamental tapestries, rugs, laces, and embroideries. Nor are these usages modern ones. The ancient Peruvians have left us a diversified fabric record — double fabrics, lenos, pile fabrics, tapestries — all made with the utmost delicacy of technique and even brilliance of color. Such mature skill could have been attained only over vast stretches of fruitful time, which certainly extend back to periods far preceding the Spanish invasion.

As in America, so also in Asia, the roots of textile endeavor were firmly founded from the earliest times. Looms existed all over the world, from the shores of the Mediterranean to the foggy islands of the Bering Straits, in India as in Peru. In the story of their development from a series of vertically supported strands, weighted sometimes with human skulls; from the web stretched across a hole in the ground, on the edge of which the weaver sat; through the Chinese drawloom and the Jacquard loom; to the automatic loom of today, the story of the rise of civilization can be read.

The art of spinning was in large measure responsible for man's advance to a nobler civilization. It was also something of a leveling influence, continually working in an age when noble and serf were as widely separated as Kipling's East and West. But whether of high birth or of low degree, the unmarried woman who used a distaff was a spinster. And the word "distaff" itself came to mean woman's authority and domain and even to refer to women collectively and genealogically in the phrase, "the distaff side."

Man has a universal urge to express himself by means of color. Colors have long had significance in heraldry, in flags and banners, in robes and uniforms, apart from



Portion of the design from an old Peruvian fabric. This is an example of double fabric, in which two distinct cloths interlace with each other horizontally and vertically to form the pattern. The material is reversible, the design appearing in opposite colors on the back — a difficult weaving technique on a hand loom for a pattern as complex as this. It evidences an advanced stage of development of the art.

Portion of an old Coptic fabric, showing the principle of tapestry weaving. Here the vertical yarns of the picture were carried by shuttles interweaving individually only for a part of the distance across the warp. A varicolored pattern is thus formed, of any desired degree of complexity.

simple purposes of design. In early England, there were three ranks of the bardic order: The druid, or priest, wore white, the sign of purity and holiness. The bard, or poet, wore sky blue, the color of peace and tranquillity. The leech, or healer, wore the green of woods and fields, symbolizing the forces of nature. The postulants for the various orders wore not the solid colors of the initiate but rather garments striped in the colors appropriate to their chosen calling. The pure white uniform of the graduate nurse, as contrasted with the checks or stripes worn by the student nurse in our modern hospitals, is perhaps a survival of this ancient practice.

Color in a fabric becomes almost a living thing. From faintest tints to deepest tones, the softness and depth of velvet contribute to the richness of hue. Texture lends a feeling of majesty to the purple already regal in significance. Shining satin and cloth of gold may equally well become a blaze of glory. It is said that by the last quarter of the Nineteenth Century, M. Chevreul, director of dyeing for the Gobelin manufactory in Paris, developed for their extraordinary tapestries a color scale of some 14,420 different tones.

Of even greater fascination than the colorings of fabrics, however, is the variety of fabric in itself. Silk for many years was worth its weight in gold. Heliogabalus is supposed to have been the first emperor to wear all silken garments. Yet in time silks became so popular, and the manufacture and sale of them so profitable, that the code of Roman laws, as revised in 533, gave a monopoly of silk manufacture to the court. Looms operated by women were set up there, and fabrics for the exclusive use of the court were woven for many years. Then developed the technique of wrapping yarns with narrow strips of gold leaf, yarn that later was to be woven into cloth or to be embroidered upon a fabric. These gold-leaf cloths were known as *tyssewys*, and the thin sheets of paper placed between the folds of fabric for its protection came to be known as "tissue papers."

During the medieval and modern periods, other ways of creating fabrics had their origin. Knitting might be noted as a first example. Actually the origin of knitting is veiled in obscurity. Whether it came into being in Scotland or Spain or Italy is still a question to be argued. In any case, Edward VI of England was presented with a pair of long Spanish stockings, and Queen Elizabeth, having discovered the superiority knitted stockings offered over the clumsily cut and fitted woven ones then in general use, would wear no other. At this time also, an English clergyman named William Lee is said to have invented a knitting machine operated by hand, which embodied the fundamental principles now found in modern power-driven knitting equipment.

Netted fabrics, in which the yarns are tied together, were made in Egypt thousands of years ago, and such fabrics appear today not only as laces but as fish, hair, tennis, and laundry nets. Braided fabrics, in which the yarns are plaited together, the same yarns forming ultimately the warp and filling of the structure, are also very old. Excavation of an ancient Celtic grave hill in Yorkshire revealed a body wrapped in a fabric made of braided strands of wool. Although the range of pattern and the width of a braided material are limited, compared with those of a knitted or woven fabric, braided products are still very much an article of commerce. They serve even today as the life line connecting the paratrooper with his parachute.

Lace, one of the most expensive of textiles when handmade, is produced with extremely simple instruments, as is true of most handmade fabrics. Needles, pins, bobbins, and a support (it may even be a pillow) are employed. Thus there is "needle-point" lace as well as "pillow" lace. The making of point lace is much the more ancient art of these and originated in Italy in very early times. Pillow lace, on the other hand, was probably first made in 1561 by Barbara, wife of Christopher Uttmann of Annaberg, Germany. Many varieties are well known and are named for the places of origin, as Brussels, Alençon, Lisle, and Honiton.

The nature of many fabrics with which we are familiar today is generally indicated by their very names, all of which have something of a world-wide flavor. The word "velvet" probably comes via the Italian *vellúto* from the Latin *villus* for shaggy. The self-patterned silks, needing no coloring of the yarns in order to define their design, were called "diaper cloths," from the Greek *diaspros* — Latinized to *diasper*, meaning, originally, pure white; later, clearly separated. The "canvas" used in sails, in industrial applications such as webbing, belting, and filters, and as a foundation for the paintings by the masters, derived its name from the hemp of which it was originally fabricated, that is, *cannabis*. Quite probably the word "taffeta" has come to us from Persia (*tâftah* — a woven material) through Italy (*Continued on page 152*)

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Research on Sugar

A LONG-RANGE program of research on sugar, one of the least understood scientifically of the products of nature, will be undertaken at the Institute in co-operation with the newly established Sugar Research Foundation of New York. Plans for the project, which is expected to lead to new and important uses for both sugar and its numerous relatives of the carbohydrate family, were made public on December 8 in a joint announcement by President Compton and Joseph F. Abbott, President of the Sugar Research Foundation, which has made a grant of $125,000 for a five-year program of research.

The foundation was created for the development of fundamental knowledge in carbohydrate chemistry, biochemistry, and nutrition. Membership is open to all producers and processors of sugar in this country, Puerto Rico, Hawaii, and Cuba.

Dr. Compton, in announcing the co-operative arrangement with the foundation, said: "The new program is another step in the Institute's long-established policy of co-operation with industry in fundamental research to improve industrial processes and develop new products. The project we are about to undertake is a pioneering plan of national significance in that it promises substantial benefits not for one organization but for an entire industry.

"The rewards of scientific research in co-operation with industry are by no means restricted to the development of new products, for the discovery of new knowledge in any branch of science invariably proves to be a contribution to advanced technical education in associated fields. Thus this sponsored research on sugar makes it possible for the Institute to continue and expand the program of fundamental investigations in the field of carbohydrate chemistry which has been in progress for several years.

"We are particularly glad that Robert C. Hockett, Associate Professor of Organic Chemistry, who has been given leave of absence from our Faculty to become scientific director of the Sugar Research Foundation, will be in charge of this broad program.

"The sugar industry is to be commended for its public service and vision for making possible this objective research. I feel sure it will be rewarded by results of great scientific value to the public."

Commenting on the project, President Abbott of the research foundation, said: "It is anticipated that the chemical studies conducted under the arrangement with Technology will not only extend knowledge of the role of sugar and other carbohydrates in the human body but also will unfold wholly new industrial uses for sugar and its derivatives. It is our hope that the collaboration between the industry and this outstanding technical institution will prove to be of great benefit to science and the general public, as well as to the industry.

"An important objective of this broad research program will be the training of scientists in the field of carbohydrate chemistry to prepare them for service in the industry for further technical studies. Provision has also been made for fellowships for young graduate students who are candidates for advanced degrees to permit them to continue their work in this promising field. The number of carbohydrate chemists in this country is extremely limited.

"The operation of a laboratory at Technology is the first project in the announced program of the Sugar Research Foundation, which embraces comprehensive research and public educational projects to demonstrate the value of sugar and sugar products in the diet; the develop-

Joseph F. Abbott, President of the Sugar Research Foundation, and President Compton signing agreement for a long-range program of research on sugar by M.I.T. and the foundation. Robert C. Hockett, scientific director of the foundation and former Associate Professor of Organic Chemistry at Technology, is standing.

Navy V-12 students pass in review on Briggs Field.

ment of new uses for sugar and its by-products; and transmission to the public of pertinent and accurate information about sugar as a food.

"Sugar, whether from cane or beets, is one of the purest chemical substances known to man and is produced in enormous quantities at relatively low cost. Use of it as an inexpensive source material for chemical conversion to substances which can be utilized for other purposes than as food is an interesting scientific challenge which demands the most advanced investigation."

Recollections of Thomas A. Watson

BY MERTON L. EMERSON

From time to time, The Review has opportunity to present stories and sidelights of Technology history which have in the rush been little known to many Alumni. Among these, accounts of notable figures in the alumni group are of especial interest.

FAMOUS as the man who first heard the spoken word over the electric telephone — Bell's message, "Mr. Watson, come here, I want you!" — Thomas A. Watson, '94, had a distinguished career as an inventor, administrator, and philosopher. Both he and Mrs. Watson entered the same Class in the Institute some ten years after their marriage, many years after Watson had ended his association with the telephone business.

My own first remembrance of Thomas Watson is at about the time I was in grammar school in the town of Braintree, Mass. In the same class with me was Mr. Watson's son, Thomas, Jr., who died in early youth. Mr. Watson was chairman of the school board. I recall him as a kindly, diffident sort of man, who sometimes would read to us from Shakespeare or from other books that did not seem to have much to do with the world in which we were then living. Many years passed before I appreciated that Mr. Watson, besides being a pioneer in telephony, was, with Mrs. Watson, responsible for the town of Braintree's being among the first municipalities to have kindergartens, domestic science teaching for girls and manual training for boys, and a municipal electric light plant. It was shortly before this time that Mr. Watson and his wife had attended the Institute and studied geology under Professor William O. Crosby, '76, with whom he had a lifelong friendship. Because of his continued interest in geology, he would often take small groups of boys and girls on trips about Braintree, into the Blue Hills, and particularly to the famous quarry which has long since disappeared but part of which, as seems quite appropriate, is the present site of Watson's pioneer shipbuilding plant, now owned by the Bethlehem Steel Company. Rare trilobites were found in this quarry, and I well remember hearing Mr. Watson say that we were standing there on one of the oldest parts of the earth's surface.

Thomas A. Watson was born in Salem, Mass., on January 18, 1854. His father operated a livery stable which had 100 horses and must have been a sizable business for that time. Watson's early schooling, as far as actual learning was concerned, apparently amounted to very little until, after attending high school for a year or more in Salem, he went to a business school in Boston for some six months. Here he learned the rudiments of bookkeeping, banking, and commercial law, which proved practical tools for him in his future career. His eyes were poor, and so he turned to a trade, starting first as a carpenter; since that work was too heavy for him, he became an apprentice in the machine shop of Charles Williams in Boston.

This association with Charles Williams was the turning point in his career, for it was in this shop that Alexander Graham Bell was carrying out experiments on his inventions of "a harmonic telegraph." Watson in two years became a skilled journeyman, a practical inventor, and a maker of models and experimental apparatus. Bell recognized his ability and made him his assistant. It seems probable that Bell, who at that time was a young professor in Boston University, was the first highly educated man with whom Watson had ever come in contact. Bell's cultural effect on Watson's future life was very marked, as is shown in later years by his studies of art, music appreciation, voice, economics, geology, and human relations.

The development of the telephone is, of course, a story by itself. As the history of telephony shows, however, there is no question that Watson tremendously hastened application of it into early commercial use. Perhaps his real ability at that time can be measured by the fact that part of the consideration for his leaving Williams' shop and going with Bell in 1876 was that he was given a one-tenth interest in all of Bell's patents. His testimony in later years helped sustain Bell's pioneer patent in its long history of litigation.

During this busy period, while Watson was chief engineer, general manager, and the operating head of the National Bell Telephone Company, he took out more than 60 United States patents, covering telephone inventions that are in use today. In May, 1878, he hired as his assistant Theodore N. Vail, who later was for so many years president of the American Telephone and Telegraph Company. Watson resigned from the telephone company in 1881 at the age of 27 years.

After extensive travel in Europe, which greatly improved his health, he married Elizabeth S. Kimball of Cohasset, Mass., and they went to California to live. Shortly after, they returned to Braintree, where Watson, upon discovering that he could not revolutionize farming in rocky New England, established a small machine shop on his riverside farm. This shop was the beginning of the Fore River plant of the Bethlehem Steel Company.

Upon his retirement from the Fore River Ship and Engine Company after its reorganization in 1903, Watson did some commercial geological work with Professor Crosby, visiting Alaska several times. Later, with Mrs. Watson, he spent much time in Europe in the study of art and music appreciation, in the study of the speaking voice, and in travel. He wrote some plays in this period and toured England and Scotland with a Shakespearean company in which both he and one of his daughters took active parts and of which he was the financial angel.

The telephone was once more brought back into his life in 1914, when the American Telephone and Telegraph Company persuaded Watson to undertake lectures on the story of the development of that business. With Alexander Graham Bell, he inaugurated the opening of the first transcontinental telephone line upon its completion on January 25, 1915. From that time until his death, he was active in lecturing and writing on the history of telephony. He died on December 13, 1934.

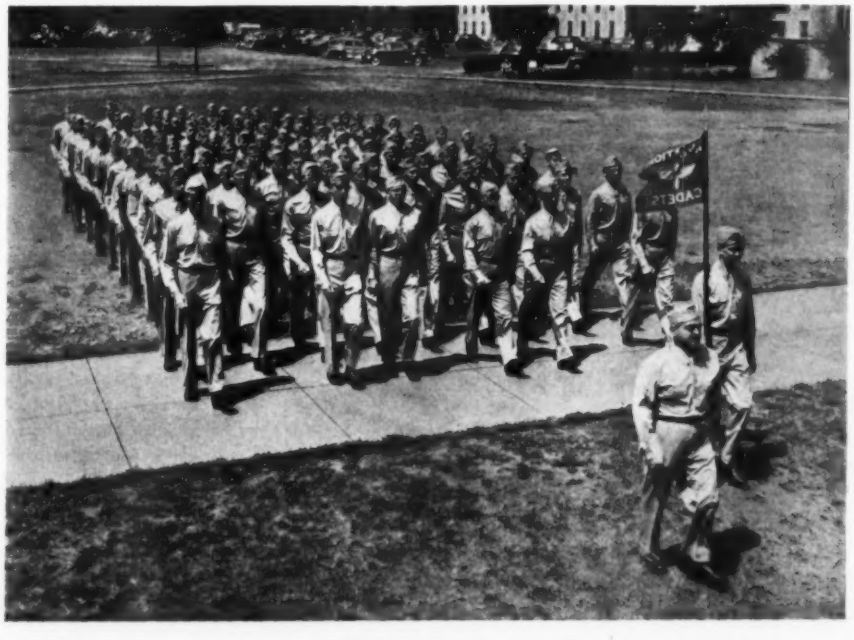
Thomas Watson was a fellow of the American Institute of Electrical Engineers. He was honored by Union College with the degree of master of arts, by Stevens Institute of Technology with the degree of doctor of engineering, and by the University of New Hampshire with the degree of doctor of science.

Technology men can remember with pride that this fellow Alumnus was the first person to hear words transmitted by electricity; that he constructed with his own hands the first electric speaking telephone and ran the first telephone wire; and that not only a pioneer in the modern field of research, he was also a man of unusually wide cultural interests.

Reciprocity

ARRANGEMENTS have been completed for an exchange of graduate students and members of the staff of the Institute and the Imperial College of Science and Technology of London. The plan will go into effect as soon as possible. This pleasant alliance between the two scientific and engineering institutions was brought about as a result of conversations between Dr. Compton and R. V. Southwell, Rector of the Imperial College of Science and Technology. Plans for the exchange have been approved by the executive committees of the Imperial College and the Institute.

The plan offers students and staff of both institutions unusual opportunities for studies of educational methods and industrial technology of the two countries. In announcing the reciprocal arrangement in England, Dr. Southwell said: "This is an active step to implement the purpose of our charter, which is to give the highest specialized instruction and to provide the fullest equipment



Aviation cadets cross the walk to Walker in the course of evolutions characteristic of the times at the Institute.

for the most advanced training and research in various branches of science, especially in its application to industry."

Dr. Compton welcomes the plan as a manifestation of the cordial co-operation between British and American scientists, whose personal and professional friendships have been intensified by a constant exchange of information on technical developments in war research.

Filial Roster

SONS of 37 Alumni of the Institute are following in the paternal footsteps through enrollment in the present freshman class. Alteration in the general enrollment situation of American colleges and universities is indicated by the fact that the list this year compares with one of 47 sons registered as freshmen last year. The list for the present class follows:

Son	*Father*
Richard M. Adler	Julian E. Adler, '13
Gale Allen	Howard B. Allen, '18
John F. Allen	Andrew F. Allen, '12
Joseph R. Altieri	V. Joseph Altieri, '23
George B. Bailey	George B. Bailey, '22
John E. Bent	Roderic L. Bent, '19
Peter Bolan	Robert S. Bolan, '19
Edward H. Bowman	Harry L. Bowman, '14
Harold S. Dodge	Harold F. Dodge, '16
William R. Frazer, Jr.	William R. Frazer, '22
Malcolm Gordon	Barnett D. Gordon, '16
Harland A. Gray, Jr.	Harland A. Gray, '20
Alexander E. Halberstadt, Jr.	Alexander E. Halberstadt, '21
Randall J. Hogan, Jr.	Randall J. Hogan, '22
Harold L. Humes	Harold L. Humes, '22
Francis N. Kurriss	Francis J. Kurriss, '23
Burton A. LeVine	Harry C. LeVine, '18
Colin McCready	Harold McCready, '09
James G. Moir, Jr.	James G. Moir, '20
Henry M. Morgan	James F. Morgan, Jr., '14
Joseph S. Newell, Jr.	Joseph S. Newell, '19
Robert W. Noce	Daniel Noce, '21
John E. Pinkney	William Pinkney, Jr., '19
William B. Ramsey	J. Raymond Ramsey, '17
Frank P. Smith, 2d	Oliver V. P. Smith, '21 (deceased)
Robert R. Smyth	Ralston B. Smyth, '19
Frank R. Stevens	Raymond Stevens, '17
Robert E. Tisdale	Ellis S. Tisdale, '15
George K. Turner	Rodolphus K. Turner, '23
John M. D. Walch	Donald E. Walch, '22
David L. Walton	Charles O. Walton, '13
Gerard Walworth	Walter F. Walworth, '19
Thomas E. Weil	Edgar H. Weil, '13
Frank T. Westcott	Frank T. Westcott, '22
Arnold B. Whitaker	William G. H. Whitaker, Jr., '04
John E. Whitman	Percy G. Whitman, '13
Arthur J. Wilson, Jr.	Arthur J. Wilson, '23

James Vaught Dotson, 1914–1943

JAMES V. DOTSON, research associate in the Department of Meteorology, died in an airplane accident in Vermont on November 26. The flight was one of the first of a series planned to test equipment developed by a research project on the de-icing of aircraft, which he was directing at the Institute under the Division of Industrial Coöperation and in collaboration with the United States Army.

Dotson was born in Nashville, Tenn., on January 29, 1914. After taking his bachelor's degree in electrical engineering at the University of Tennessee, he came to Technology in 1937 as a graduate student in the Department of Physics. He was a research assistant in the Department of Electrical Engineering from 1937 to 1939, studying the physical and chemical properties of mineral insulating oils. Transferring his activities to the Department of Meteorology in 1941 as a research associate, he became identified with the program of research concerned with ice formation on aircraft. Through his resourcefulness and imagination he was instrumental in enlarging greatly the size and scope of this research. Dotson showed much promise both as an experimental and as a theoretical scientist, and made effective contributions on both of these counts to the problems on which he worked.

He is survived by his wife, Joan Grant Dotson; his parents; and a sister.

With the Council

CHANGE of the date of Alumni Day 1944 to Saturday, February 26, was emphasized at the 235th meeting of the Alumni Council, which was held at the Smith House in Cambridge on the last Monday in November. The shift from the date earlier announced was necessitated by a change in the date of graduation for the Class of 2-44. Plans for the festivities of February 26, the Council was told, are progressing properly. Committees named by Herbert R. Stewart, '24, chairman, Alumni Day 1944, were elected by the Council as follows: *publicity*, Ralph T. Jope, '28, chairman, Henry B. Kane, '24, James Donovan, '28, John J. Rowlands and Frederick G. Fassett, Jr., staff; *ladies' events*, Mrs. Leicester F. Hamilton, chairman; *Class Day*, John D. Mitsch, '20, chairman, Eugene Mirabelli, '19, Paul M. Chalmers, staff; *registration*, Donald P. Severance, '38, chairman, Joseph C. MacKinnon, '13, Robert M. Kimball, '33, Wolcott A. Hokanson, staff; *ways and means*, Horace S. Ford, staff, chairman, Carl M. F. Peterson, '29, Delbert L. Rhind, staff; *dinner*, Josiah D. Crosby, '21, chairman, Arthur L. Shaw, '09, Larcom Randall, '21, James A. Pennypacker, '23, Robert C. Casselman, '39.

Reporting on the Alumni Fund, Director Kane stated that the leads over 1942 reported last month were continuing. As of November 29, a total of 8,063 contributors had given $96,880.26, the average being above $12.

Francis J. Chesterman, '05, President of the Alumni Association, then introduced as speaker of the evening George R. Harrison, Dean of Science, whose subject was announced as "A Hedgehopping Tour Around M.I.T. with the Dean of Science and Glimpses of War Work through His Eyes."

Dean Harrison's talk included many anecdotes ranging from the difficulties of the conversion of the Institute's heating system to burn coal instead of oil, to enlargement of staff and facilities of the Medical Department in order to care for the increased demands imposed by the greater number of people now busy at the Institute. From these, and from stories of the operation of the Institute cyclotron on an accelerated schedule, Dean Harrison went on to comment on the war effort in general. Pointing out the importance of science in developing weapons and otherwise influencing the conduct of warfare from the beginning of history, he commented (*Concluded on page 170*)

COPPER

IS THE SHIELD OF DEMOCRACY

The spectacular rise in the American Standard of living during our lifetime has been keyed to copper. On the day of Pearl Harbor, 20 billion pounds of it were busy doing the nation's work. Through it, Americans enjoyed protection and comfort impossible elsewhere. Today, of course, all copper is used for the war effort. And not a plane flies, not a ship sails, not a bullet is fired without copper, brass or other copper-base alloys playing an indispensable part. But tomorrow, when peace is won, Revere copper will function again in the vital parts of automobiles, home appliances, houses, industrial equipment and a thousand commercial products. And in addition, Revere metals will be ready to help turn war-born inventions and ideas to become the working realities that will bring you more freedom, more security, more ample living. Revere will welcome inquiries about copper and its versatile alloys.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: 230 Park Ave., New York 17, N. Y.

AVIATION AFTER THE WAR

(*Continued from page 138*)

radically new, something revolutionary, comes along to raise the ceiling and to let the curve break upward again. Little is in sight which will account for such change in the next few years, war or postwar. Thousands of improvements in detail are being made which are constantly bettering our aircraft designs, making for increased reliability and utility. Each brings us nearer, inch by inch, to the ceiling. But the lines of physical limitation appear to be holding. The break-through that would unleash the wonders of the World of Tomorrow is not yet in sight.

Of course the military people have up their sleeves things which they are not talking about. That is to be expected. In wartime especially, no one shows his secret weapons. But it is a safe bet that, given adequate research facilities and first-rate research talent for both sides (as is the situation in the present war), neither is likely to pull many unsuspected rabbits out of hats.

Flying wings have been mentioned. The usual conception is an airplane unencumbered by fuselage, tail surfaces, or protruding engines, with pilots, passengers, cargo, and power plants housed wholly within the boundaries of the wing. Such machines should be more efficient than the conventional types. Their proponents claim that with a considerable percentage of the normal drag out of the way, they will go faster with less power, farther with less fuel. Such planes have been built experimentally, more are abuilding.

The all-wing type has limitations: For its advantage to be realized to the full, it must be made too big to be presently practical or economically justifiable.

In the laying out of a conventional airplane, the *weight* of the combined passengers, pilots, fuel, and cargo more or less determines the over-all size of the aircraft. For a selected gross weight, a designer arrives at a wing of suitable span and chord and then attaches to it a housing of the most efficient shape to surround his inanimate and human cargo. In the laying out of a flying wing, however, *space* is a determining factor. The designer must lay out a cabin with suitable headroom, length, and breadth, and then provide a wing big enough to enclose it completely. Over-all dimensions immediately become Gargantuan.

This is not the place to go through the calculation, but studies have indicated that the all-wing type of airplane for normal passenger use begins to be practical at a gross weight of about 350,000 pounds. This is a long jump ahead. Today's passenger airplanes range from 25,000 to 80,000 pounds gross. Most air-line executives, in planning for the potential traffic of the next five to ten years, believe that the optimum airplane for their purposes will weigh in the neighborhood of 100,000 pounds. And even the most optimistic planners for transocean services limit their thinking to airplanes of about half the size of the minimum flying-wing type.

For military use, the foregoing argument does not hold. It is possible to conceive of a fighter pilot lying prone inside a very small wing, or of bombers whose highly concentrated dead loads readily lend themselves to stowage within a wing of practical dimension.

There is little question that the all-wing type would show improvement over the best of the current designs, provided its undesirable characteristics can be overcome. Its stability in turbulent air is debatable, and there are problems of control and of power plant installation yet to be solved. Nevertheless, it would only be another step, albeit a substantial one, toward the present ceiling. It does not appear to be the revolutionary idea that will carry us upward into a completely new stage of development.

The successful use of the towed glider in military operations has also put fantastic ideas into people's heads. The aerial "train" sweeping across the skies, casting off cargo and passenger gliders over cities, swooping low to snatch freshly loaded tows from the ground, is technically possible. The late Richard C. du Pont and his associates have carried this development to the point of practical use. They have demonstrated that it can be done. After the war, however, the glider train will be judged by only one criterion — cost per ton-mile operated. It is strange how many people, including engineers and businessmen, seem to think that they can get something for nothing. The addition of two or three gliders behind a powered airplane materially ups the drag, reduces speed, and increases to a considerable degree the power required for flight. While an increased weight of goods may be carried by the combination, indications point to a marked increase in ton-mile cost through the use of gliders, as compared with the cost for an equal weight of cargo carried in powered airplanes at higher speeds.

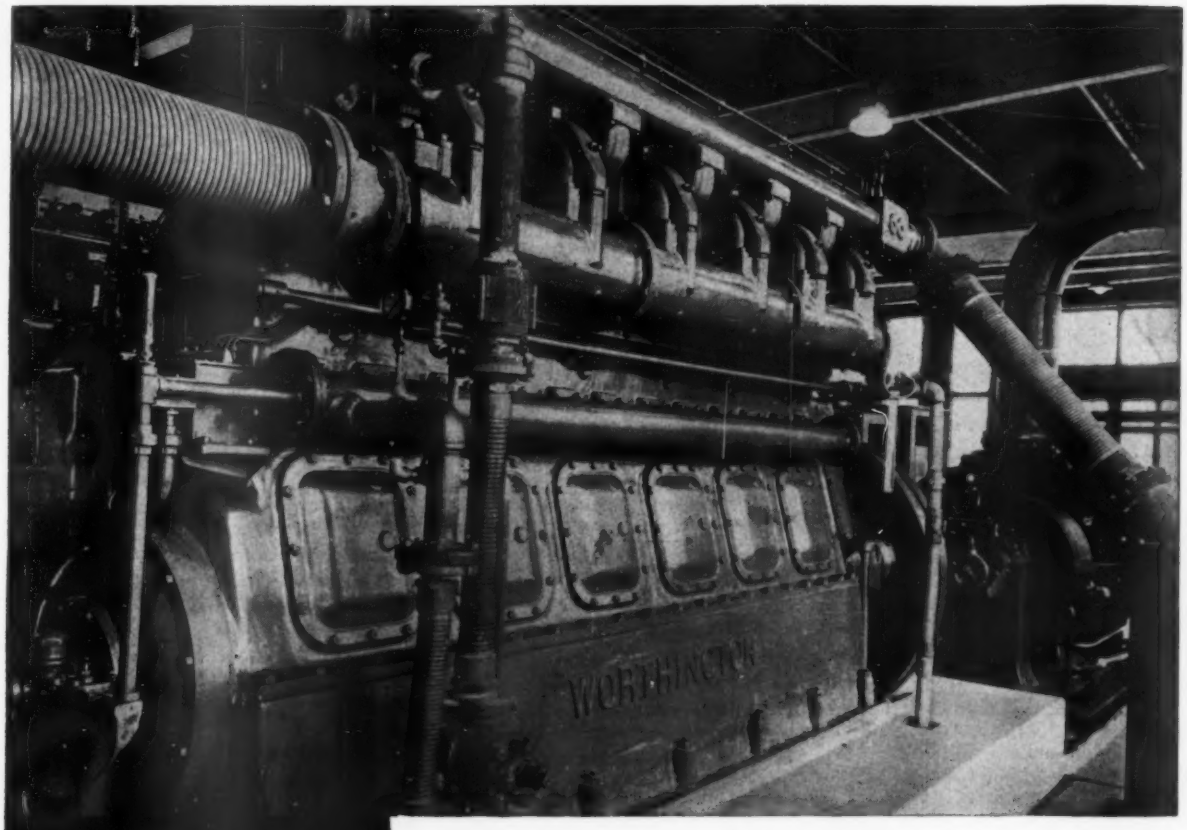
Although the cargo-carrying glider train may have military justification, it is unlikely to play a very important part in the immediate postwar air-transportation picture unless something new turns up in the aerodynamics of gliders or in the economics of powered aircraft. Gliders hold out little promise of affecting present ceilings one way or another. If they ever prove economically useful, they will do so in the period *after* the next upthrust in efficiencies, not before.

The helicopter is frequently cited as the solution of most of aviation's problems. Although remarkable work has been done by a few pioneering experimenters, little was actually accomplished until recently, when the military took some interest. The Army has an experimental section at Wright Field which is exploring helicopter possibilities. The Navy has shown interest in the type for antisubmarine and convoy duty. A veritable flood of publicity has been released by each activity. Even so, rotary-wing projects still carry low priorities. Contrary to popular belief, the actual amount of helicopter test flying that has been accomplished in this country is shockingly small. Probably it adds up to less than a thousand hours. The number of such machines that have been flown could be counted on one's fingers.

Latterly, the pace is being accelerated. Funds have just been provided for specialized equipment needed for research at government laboratories. Meanwhile, dozens of concerns have capitalized on premature publicity while a few interested manufacturers and at least one university have done some real work. The total volume is microscopic, however, as compared with the labors that must be performed before a helicopter for Everyman is on the market. Here again is a good example of the ease with which wishful thinking in aviation can outrun actual accomplishment.

When it does come, the break will more likely be touched off by something outside of aeronautical engineering proper, possibly from the field of chemistry or of heat engineering. We are still a long way from utilizing all the

(*Concluded on page 152*)



PENFLEX Metallic Hose

. . . Armored for Safety
. . . Flexible for Service

Uninterrupted Service and Safety are important factors in generating power for War Production. PENFLEX Metallic Hose with 4-wall interlocking joint construction and 3/8" "come and go" per lineal foot of length is designed for long life, trouble-free service on intake and exhaust lines, oil, water and other connections. It resists thermal and mechanical strains and fatigue . . . it absorbs vibration and provides safe, economical service.

PENFLEX WELD corrugated, jointless Tubing gives leakproof service on fuel oil feed, circulating water, and starting air lines.

Full data in practical diagrammatic form in Bulletin 71.

In sizes 1" to 18" I. D.

PENFLEX METAL HOSE

PENNSYLVANIA FLEXIBLE METALLIC TUBING CO.

7211 Powers Lane, Philadelphia, Pa.

ESTABLISHED 1902

AVIATION AFTER THE WAR

(*Concluded from page 150*)

energy locked in fuels. This condition, of course, is true for practically all prime movers or power generators. In the transformation of the chemical energy of fuels into mechanical energy at the end of a shaft or into propulsive thrust behind an airplane or a ship, a very high percentage of waste occurs. Intensified study is now being made of means for utilizing more of the heat developed in aircraft engines. Ways of improving propulsive efficiency by jet reactions are being investigated. The subject is of great military interest today and, as such, is on a very confidential basis. It is a generally known fact, however, that all of the first-rate aeronautical powers are experimenting with new ways of propelling aircraft.

Everyone interested in flying over extremely long ranges has been struggling for years to reduce fuel consumption in cruising to get the maximum mileage from a given weight of gasoline. It has been considered worth while to go to almost any length to improve specific fuel consumption by a few per cent. If, however, some new type of engine or some new combination of engine propeller plus a thrust augmenter should make possible the recovery of a considerable portion of the heat energy which is now wasted, present operating ceilings would again be raised. Or, looking farther into the future, some form of atom smashing might obsolete all present power plants and raise limits to a degree beyond our imagining.

Such changes can come in only one way — by research and more research. The probabilities of lifting the ceiling by inspiration or invention are remote. No half-starved, long-haired genius is likely to stumble from his attic crying, "Eureka!" — with the solution in his hand. But the mathematician and the slide rule artists who are slowly and painfully computing and tabulating the characteristics of slightly better airfoils; the young engineers who are watching the behavior of models in wind tunnels in order to forecast and to prevent erratic behavior of the eventual plane in the air; the lads who are peering into incandescent combustion chambers or who are bending over test tubes to gain another tenth of one per cent in fuel efficiency — these are the people who are laying the solid foundation for aviation of the future.

In wartime, for obvious reasons, all laboratories are concentrating almost entirely on investigations that directly and immediately affect the war effort. All are working under directives written by the Army and Navy. Other things must wait, and into this category fall many of the problems that must be explored at length before our dreamworld aircraft can be designed.

It would be a pity if the tempo of aeronautical research should be allowed to lag in the immediate postwar years. Then, if ever, we shall need an all-out effort to improve the efficiency of aircraft. The push for quantity will be over, the drive for quality must be redoubled. Instead of striving for maximum military performance regardless of cost, we must shift the emphasis to problems of maximum efficiency at minimum operating cost, to improvements of control, and to greater safety for the citizen who flies his own plane.

There is no quick and easy road. Constant research in a dozen different fields must be relentlessly pursued and the results painstakingly analyzed to produce solutions for aviation's problems, now and hereafter.

FABRICS OF OUR FATHERS

(*Continued from page 144*)

(*taffettà*). "Flannel," on the other hand, may have evolved from the Welsh for wool, namely, *gwlanen*. From the Latin *pilus*, meaning hair, through the French *pluche*, we get our "plush." "Nainsook" comes from the Hindu word *nainsukh*, meaning eye pleasure.

Other fabrics have names derived from their places of origin. "Sarcenet" comes from Saracenicum — silk woven by the Saracens. "Damask" was Damascus silk. "Muslin" came from the Mesopotamian city of Mosul. The first Mohammedan capital of Egypt, Fustät, lends its name to "fustian." "Wilton," "Axminster," and "Brussels" are names of carpets and of the towns noted for early manufacture of them. Calicut, India, gives us "calico," representing a tremendous range of printed cotton cloth, proceeding slowly at first from beneath crude hand blocks and later pouring in torrent from the whirling copper cylinders of the printing machine. A tapestry hanging and a curtain in general came to be known as an "arras," from the city of the same name. "Cambric" and "chambray" came from Cambrai.

Legend runs that wool combing was invented by St. Blasius, bishop of Sebaste, in the Fourth Century. Dyer in his book, *The Fleece*, described it as follows:

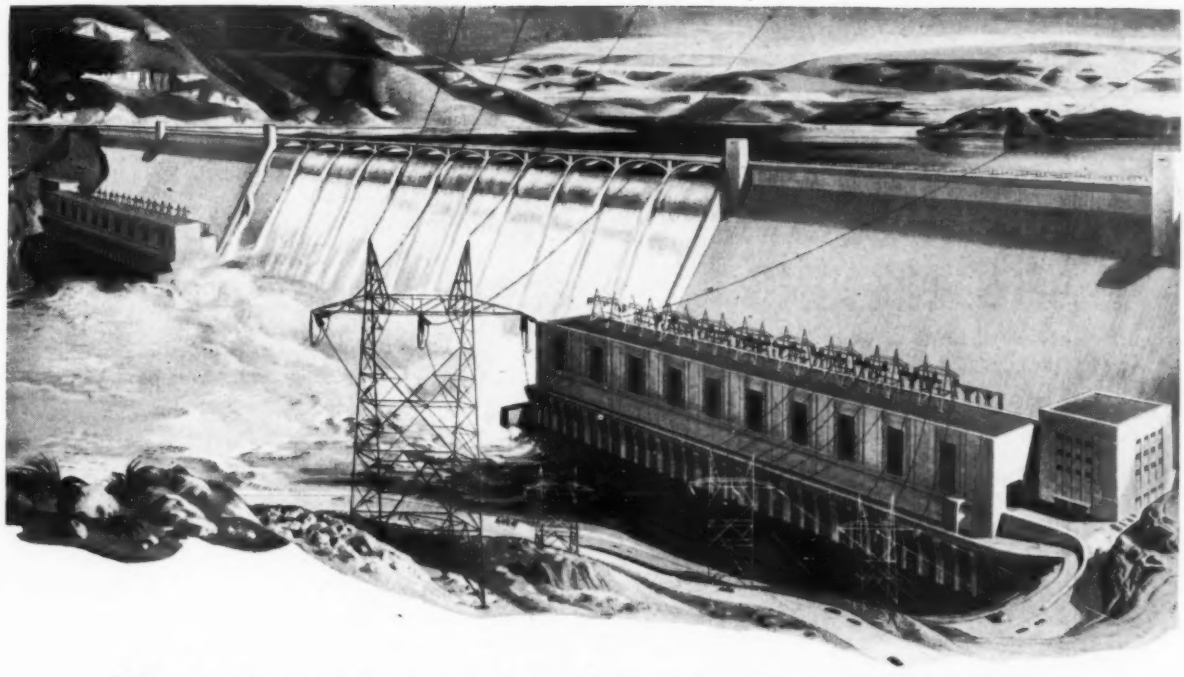
Thus in elder time
The rev'rend Blasius wove, his leisure hours,
And slumbers broken oft: till fill'd at length
With inspiration, after various thought,
And Trials manifold, his well-known voice
Gathered the poor, and o'er Vulcanian stoves,
With tepid lees of oil and spiky comb,
Showed how the fleece might stretch to greater
Length, and cast a glossier whiteness. Wheeles went round,
Matrons and maids with songs relieved their toils:
And every loom received the softer yarn.
What poor, what widow, Blasius, did not bless
Thy teaching hand — thy bosom like the morn
Opening its wealth? What nation did not seek
Of thy new-modelled wool the curious webs?

Gaul, at about the time of Caesar, was noted for a fabric which the Romans called *sagum*. Later, throughout Picardy, it became *sayon* and finally *saye*. Even after the end of the Roman Empire, *saye* lived on — not only lived on but was taken by the Franks and carried to the West to Merrie England, where it clothed no less a personage than Robin Hood. Soon the word became "sarge" and at last "serge" as we know it now.

Another garment much beloved by our ancestors — a hooded, waterproofed cape — was known as a *bura*. Eventually the hood became known as a *birrus* and thence evolved into our popular "beret." The material itself was used as a cover for tables and desks. An account book of Charles VI of France in the Fourteenth Century listed: "Two dozen parchments, an ink-horn, a penknife in a silk sheath, a bureau to cover the table." How far that word has since traveled, from a name for the piece of furniture or its cover to bureaucracy itself!

Beyond the importance of the fabrics themselves, embroidery played its role. Embroidered coats of arms were popular in Colonial times. The direction of the stitches followed the laws of heraldry: vertical for gules, diagonal (right to left) for purpure, and horizontal for azure.

(*Concluded on page 154*)

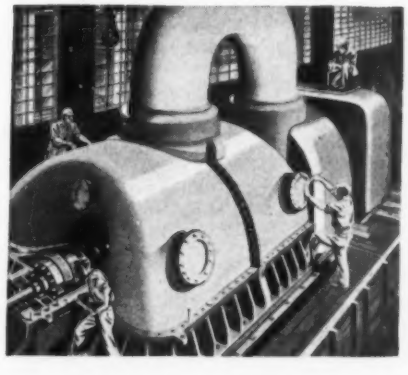


Westinghouse generators make power for a nation at war . . .

From the world's largest water-wheel generators at Grand Coulee Dam—from Westinghouse steam-driven generators in power plants throughout the nation—flow billions of kilowatts of electric power to turn the wheels of America's war industry.

Westinghouse combines the power of a thousand human skills . . .

A workman at a lathe, a girl on an assembly line, an engineer on the test floor—theirs, and the countless other skills of 103,000 Westinghouse employes, are welded into a single great production force. Their vast experience and knowledge help to produce the vitally needed power-generating equipment to drive America's mighty war machine.



Westinghouse contributes the power of immense new knowledge . . .

When the incredible weapons born of wartime research are reforged for peacetime service, the daily miracles that electricity will perform are certain to create new and finer standards of living . . . while the cost of electricity continues to decrease as our nation's power-generating capacity continues to increase. Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa. Plants in 25 cities—offices everywhere.

WANTED
for the
PHILCO
ENGINEERING
STAFF

- **RADIO—ELECTRONICS—ELECTRICAL ENGINEERS**
  Men with degrees in electrical engineering or comparable experience in radio and television.
- **MECHANICAL ENGINEERS**
  Men with college degrees or comparable experience in the engineering aspects of electrical appliances, and in designing small machinery.
- **DESIGN ENGINEERS — DRAFTSMEN**
  Men with experience in mechanical designing, especially of small metal parts and of the automatic machinery to mass-produce them.
- **PRODUCTION ENGINEERS**
  Including electrical and mechanical engineers familiar with any phase of radio, radio-phonograph and television production.
- **PHYSICISTS**
  Must have science degree in physics. Some practical experience in radio is desirable.

FOR these and other key positions—senior and junior engineers for research, project and design work, physicists and mathematicians — we are looking for men who are thinking about the future. Right now there is plenty of urgently needed war work to do. But some day peace will return — and Philco is planning to be ready for it with advanced Radio, Television, Refrigeration and Air-Conditioning products. This may be your opportunity to get ready for it too.

WRITE US TODAY

Qualified men not now engaged in work requiring their full talents, are invited to write us in detail as to their experience, education, family and draft status, and salary. Letters will be treated in strict confidence.

Employment subject to local W.M.C. rules.

WRITE TO MR. GEORGE DALE

PHILCO
CORPORATION
Philadelphia 34, Penna.

FABRICS OF OUR FATHERS

(*Concluded from page 152*)

The sampler combined the teaching of both sewing and letters. The custom was carried to an extreme in the embroidering of mottoes and other sentiments on the edges of gowns and petticoats. Writing in 1640, John Taylor, in his "The Praise of the Needle," listed many of the types of stitch employed:

For *Tent-worke*, *Raisd-worke*, *Laid-worke*, *Frost-worke*, *Net-worke*,
Most curious *Purles*, or rare *Italian Cutworke*,
Fine *Ferne-stitch*, *Finny-stitch*, *New-stitch*, and *Chain-stitch*,
Braue *Bred-stitch*, *Fisher-stitch*, *Irish-stitch*, and *Queen-stitch*,
The *Spanish-stitch*, *Rosemary-stitch*, and *Mowse-stitch*,
The smarting *Whip-stitch*, *Back-stitch*, & the *Crosse-stitch*,
All these are good, and these we must allow,
And these are everywhere in practise now.

Paul Rodier, in *The Romance of French Weaving*, strikes a keynote with his phrase, ". . . where a loom is waiting the night of savagery is over." Through art and science, the hum of the spindle and the throb of the loom have played accompaniment to progress. Their song has been modulated by the stress of war and the calm of peace. Folksong and martial air have been interwoven in gown and tapestry. Homespuns and jeans have marked the forward march of labor no less than have broadcloths and worsteds. It is perhaps symbolic that our fathers' religion and our own have seen in robe and hanging the interlacing of warp and weft to form a cross.

Weave, brothers, weave! — Weave, and bid
  The colours of sunset glow!
Let grace in each gliding thread be hid!
  Let beauty about ye blow!
Let your skein be long, and your silk be fine,
  And your hands both firm and sure,
And time nor chance shall your work untwine,
  But all, — like a truth, — endure!

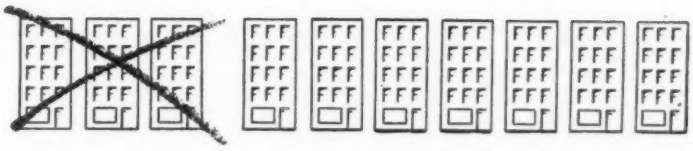
— BARRY CORNWALL

MEET TARSIUS

(*Concluded from page 140*)

Among the primates, Tarsius is the only form which has developed specialized muscular pads on toes and fingers, by means of which it is capable of a suctorial action which enables it to cling to many surfaces by pressure and suction rather than by grasping and holding. It cannot, however, walk like a fly on a vertical plane or upside down on the ceiling. On the ground or among the trees where it chiefly lives, it jumps like a frog, making leaps of about six feet in length and, in doing so, jumping about four feet into the air. This is pretty good jumping when one remembers the tiny size of the animal.

As among all primates, tarsiers are usually born singly, and from all reports the tarsier appears to be monogamous; couples remain together even when herded with others, and the male allows the female to take food away from him without protest. With regard to food, the natives in most of the regions in which tarsiers occur believe that these little creatures consume charcoal. Whether or not they do, future investigation may show. Meanwhile we have a lot to learn about Tarsius, our much neglected distant relative.

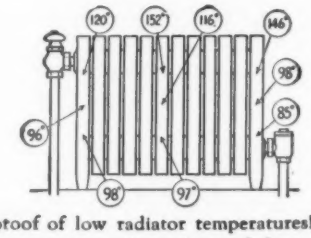


Yes . . . 7 out of 10 buildings

can get more heat with less fuel

With fuel rationing, it is more important than ever that building owners thoroughly investigate their heating systems to make sure they are not wasting valuable fuel.

Webster Engineers have found through thousands of surveys that seven out of ten large buildings in America (many of them less than ten years old) can get more heat per unit of fuel consumed.



Actual proof of low radiator temperatures! Here are actual temperatures at nine points and showing average radiator temperature of 112° F. . . . due to scientifically controlled turbulence.

Before the development of the Webster Moderator System, steam was either "off" or "on" except for the control provided by the radiator supply valve. There was no better way to control *quantity* of steam delivery to radiators.

The Webster Moderator System prevents the discomfort of "scorching hot" radiators by making possible low radiator temperatures . . . Eliminates annoying and fuel-consuming surges of heat—or "cold spots"—by supplying heat *continuously* to all radiators through orifices and central controls. There is no waste of valuable fuel through overheating.

If you are interested in getting more heat with less fuel, write for "Performance Facts" This free booklet gives case studies of 268 modern steam heating installations and how they are effecting great savings in fuel.

WARREN WEBSTER & CO., Camden, N. J.
Pioneers of Vacuum System of Steam Heating :: Est. 1888
Representatives in principal U. S. Cities :: Darling Bros., Ltd., Montreal

ARMY E NAVY

Making Boosters for U.S. Army Ordnance

Webster Steam Heating

WANTED

ADVERTISING DIRECTOR

HIGH-GRADE advertising director, technical graduate, familiar with mechanical equipment used in power plants, refineries, ships. Agency experience helpful. Must be capable and responsible for all advertising details. Location Chicago. Long established and sound firm. Outline experience and education. Live wire, creative, ambitious young engineer, around 35, desired.

☆

Reply to Box C

THE TECHNOLOGY REVIEW CAMBRIDGE 39 MASS.

CONVERSION AND THE CONFEDERACY

(*Continued from page 142*)

Europe to study ordnance and arsenals there. On his return, he was sent to the Watervliet Arsenal in New York State and then went with General Winfield Scott to the Mexican War, after which he returned to ordnance work. While on duty at Mobile, Gorgas married an Alabama girl. His conservative bent inclined him against the antislavery movements of the day. When the Confederacy was organized, he went with it and was at once made chief of ordnance of the secession army.

The South's seizures of Union arms proved much more impressive statistically than they were for combat use. About 15,000 rifles had been taken, but many of these were antiquated. Of smoothbores, 130,000 fell into Confederate hands, but these were useful only at short range. In addition, the South secured 90,000 flintlocks, almost of the vintage of the War of Independence. No cavalry arms were taken. The 429 captured cannon were principally old guns in the coast defense fortifications. These were short range and of old design. The few field guns went back to the War of 1812. But there was one stroke of luck. Although there was not a manufacturing arsenal in the Southern States, Virginia seized the arsenal and armory at Harpers Ferry. The machinery from there was soon removed and sent south.

The Confederate ordnance chief had two main problems: guns and powder. He could look into the future and see that the matériel would be needed from northern

(*Continued on page 158*)

POOR & COMPANY

RAILWAY EQUIPMENT

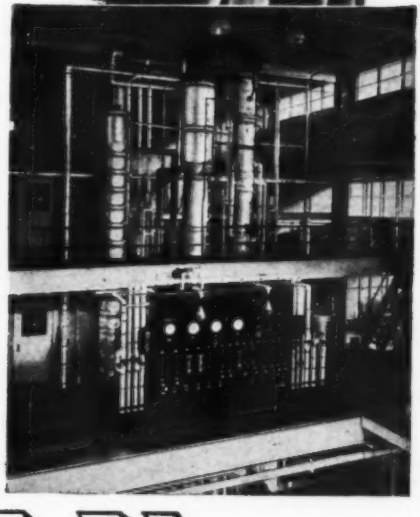
CHICAGO, ILLINOIS

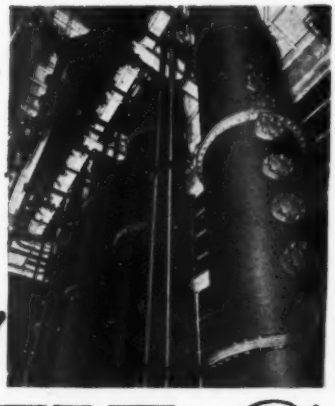
COMPLETE ORGANIZATION SERVICE

in the highly specialized fields of

DISTILLATION
EVAPORATION
EXTRACTION

PROCESSES and EQUIPMENT





VULCAN CINCINNATI

The Vulcan organization devoted exclusively to the highly specialized fields of Distillation, Evaporation and Extraction, serves the Process Industries with sound experience and assumes undivided responsibility for the development and design of projects involving these operations.

RESEARCH . . . BASIC ECONOMIC PLANNING
PILOT PLANT OPERATION
PLANT and EQUIPMENT DESIGN
FABRICATION . . . INSTALLATION
INITIAL OPERATION

THE **VULCAN** COPPER & SUPPLY CO., CINCINNATI, OHIO

CONVERSION AND THE CONFEDERACY

(*Continued from page 156*)

Virginia to Texas — and that the indifference of the Confederate railway network would almost compel manufacture in many scattered plants. And he was exactly right about this. The problem which proved most difficult was neither the shortage of saltpeter for powder manufacture, nor of lead, nor of arsenal machinery; it was the continuous breakdown of rail transport.

General Gorgas distributed his arsenals over the South, establishing them at Charleston, S. C.; at Augusta, Atlanta, Columbus, and Macon in Georgia; at Selma, Ala.; at Baton Rouge, La.; and at Little Rock, Ark. The Harpers Ferry machinery was divided between a Richmond armory, where rifle muskets were converted or manufactured, and Fayetteville, N. C., where a new armory made rifles. He set up a cannon foundry in Macon and the chief Confederate powder mill in Augusta.

The Confederate authorities were not too hampered by absolute lacks of essential military materials. Lead mines opened near Wytheville, Va., supplied most of the lead for bullets. The Ducktown and Copper Hill mines supplied copper needs until Sherman got to the south of them. Virginia and Alabama iron ores were ample for the raw pig iron needed for ordnance purposes.

More strenuous efforts had to be made to secure saltpeter. When Gorgas established the powder factory at Augusta, he put a skilled chemist and ordnance technician, Colonel George Washington Rains, in charge of it, and the latter soon began turning heaven and earth to get saltpeter. He decided that a principal source would be the floors of the limestone caves throughout the South, where large deposits of niter would likely be found. He soon published a pamphlet, which was widely circulated, entitled *Notes on Making Saltpetre from the Earth of Caves*. The shortage seemed so critical in 1862 that Gorgas organized a separate military niter and mining bureau under Colonel Isaac M. St. John, who was successful.

Rains's powder production record was quite extraordinary. A North Carolinian by birth, he served in the Mexican War. Although a chemist by profession, he became the president of some successful ironworks in New York. He managed the production as well as the technical problems of the powder factory with high success. In this, he followed the processes in use in the Waltham Abbey Government Gunpowder Works in England, but he made many improvements on them.

The Augusta mill did not close its operation until April 18, 1865. During the three years of its life, it made 2,750,000 pounds of gunpowder for the Confederate military services. At all times there was an ample supply of excellent powder for the Southern soldiers. Often it was not on hand at the point of need, but the fault was transport, not production.

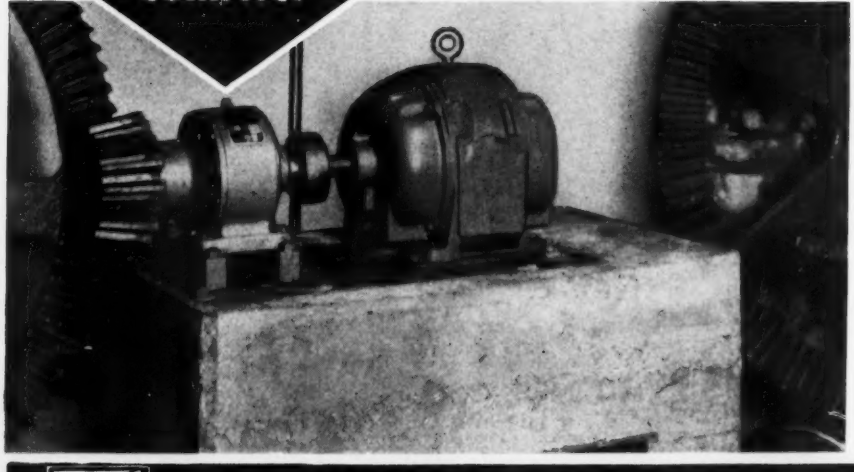
A word more about Gorgas: After the war, he turned to the field of education. In 1869 he went to the University of the South at Sewanee, Tenn., taught there and served as vice-chancellor. In 1878 he became president of the University of Alabama, which office he resigned a year later because of ill-health. He became librarian of the uni-

(*Continued on page 160*)

IT'S SO COMPACT

WHS PATENTED DIFFERENTIAL SPEED REDUCER

. . . and economical, too!



Unrivaled for space-saving ...twice as compact as speed reducers of like ratio and capacity. *Unequaled for design simplicity*...whether 3 to 1 or 30,000 to 1 reduction, the small number of parts remains the same. Quiet-running helical gears and equalized load distribution contribute to outstanding efficiency and economy.

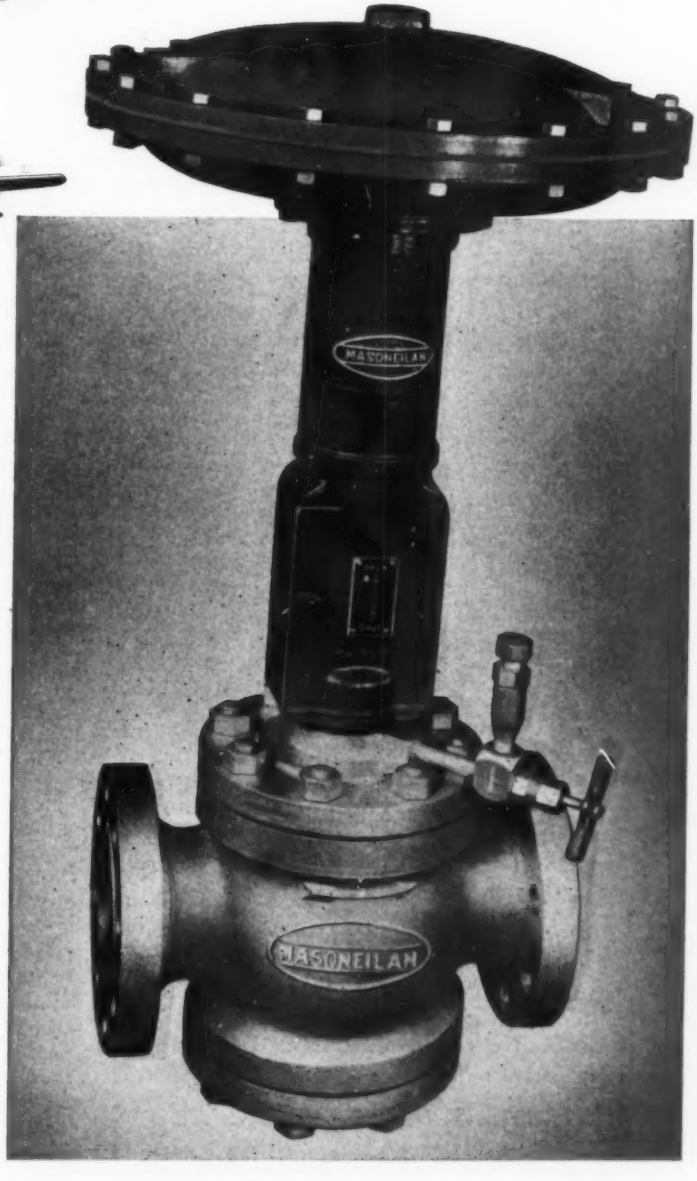
Fully described and illustrated in our new Catalog No. 144

CUTTER P. DAVIS, M. I. T. '19, President

WINFIELD H. SMITH, Inc.

55 MAY STREET... SPRINGVILLE.. ERIE COUNTY.. NEW YORK

There Can't Be Any Guess in this Gas*



*High octane gasoline used by our war-birds must be *right.* There can't be any guessing when not only life but victory is at stake. That's why automatic controls are so important in the petroleum industry.

AND that's why many refineries use Masoneilan Control Valves. Their performance and their sturdy construction have won them a top spot in the process industries.

Which in turn is why some of our friends may not have been able to get these valves when they wanted them. Naturally the most vital war-winning plants come first. If you have been disappointed remember that Masoneilan valves probably have helped produce much of the high octane gas that, night and day, propels our planes over Hitler-land with presents for Adolf.

MASONEILAN

Mason-Neilan Regulator Company

Boston, Massachusetts

Tools of Tomorrow—at work TODAY

GLOBE encircling airlines carry war material to all the fighting fronts. Time has been compressed so that no spot on the earth is farther than 60 hours away. *Distance* has become *space* to the average man and altitude is the new dimension.

This progress has been made possible in part by flight instruments which measure accurately and record the position of a plane above sea level—above the surface of the earth. From the research laboratories of Lane-Wells Company, improvements in flight instruments have been developed to aid aerial navigation and promote the safety of flight operations.

FIGHTING *Tomorrow's Tools-Today!*

LANE-WELLS COMPANY

Los Angeles
Houston Oklahoma City

BOSTON INSULATED WIRE & CABLE COMPANY
B·I·W

ELECTRIC CABLES for AIRCRAFT

LIGHTING AND POWER CABLES
SHIELDING IGNITION CABLE
BONDING WIRE ANTENNA WIRE
INSTRUMENT WIRES AND CABLES

Manufactured in accordance with latest Army and Navy Specifications

Special multiple conductor cable made to order — designed for particular applications on instruments and apparatus

BOSTON INSULATED
WIRE AND CABLE COMPANY
BOSTON, MASSACHUSETTS

CONVERSION AND THE CONFEDERACY

(*Continued from page 158*)

versity and held that post until 1882. He died a year later. His son, Colonel William Gorgas, a gifted medical scientist, became famous for his work in the Panama Canal Zone, fighting yellow fever and other tropical diseases.

Niter was not the only component in grievously short supply. Artillery shells needed detonators, for which fulminate of mercury was the accepted material. The Confederates had to import the mercury needed to make the substance, and the blockade made this impossible. Gorgas and his chief subordinates sought a substitute, and procured one by combining sulphurate of antimony and chlorate of potash. So there was no end to detonators.

An almost equally useful improvisation occurred in small-arms ammunition. The stock of percussion caps was running out, and the authorities were hard put to it to keep up even a hand-to-mouth supply of caps through the accustomed handicraft methods of manufacture. But it so happened that among the machinists and mechanics Gorgas sent south to his Augusta enterprise was a mechanic from the railroad repair shops of Lynchburg who was a veritable genius in building new-purpose machinery. He pondered the problem of mass production of percussion caps, and devised and built a machine that could fill and press a million caps a day. Thenceforward the supply of these caps was not a Confederate headache.

The design and production of Confederate naval ordnance were directed by another interesting and highly competent technician, John Mercer Brooke. Not only did he raise the burned and scuttled steam frigate, the U.S.S. *Merrimac*, and convert her into the world's first ironclad, which fought a drawn battle with John Ericson's *Monitor* in March, 1862; but he also designed the best naval gun employed by either navy during the Civil War.

This inventor-administrator was born near Tampa, Fla., in 1826. His father, Brevet Major General George M. Brooke, came from Virginia; his mother came from the state of Massachusetts. The youngster had his first sea service as a midshipman under Farragut in 1841. When the Naval Academy opened at Annapolis, he went there for two years, being graduated as an ensign in 1847.

Brooke's first professional work was with a hydrographic party. In 1851–1853, he was a principal assistant to the famous Matthew Fontaine Maury at the United States Naval Observatory in Washington. During this tour of duty, Brooke invented a deep-sea sounding apparatus which for the first time enabled hydrographic parties to bring up ocean floor specimens from the bottom of the sea. In the late Fifties, he was ordered to take a voyage from California to China to survey a better route for American shipping. He did not get back to the United States until shortly before the outbreak of the Civil War.

In April, 1861, Brooke resigned his commission in the United States Navy, and in September, 1862, became a commander in the Confederate Navy. His first major duty was to raise and rebuild the *Merrimac* and control the work on it until the ship, rechristened the *Virginia*, went into battle under the command of the then Captain Franklin Buchanan on March 8 and 9, 1862.

In reconditioning the raised hull, Brooke employed what he entitled the "submerged ends principle," of

(*Concluded on page 162*)

Said the Hatter...

Gunmaker...

and Food-Packer...

to the man with the *new-product headache:*

For nearly seventy years, scores of manufacturers in every line of industry . . . in peacetime and in war . . . have brought to Taft-Peirce their knotty problems in design, development, tooling, and contract manufacturing. Their reasons have been as varied as their products . . . lack of plant facilities . . . lack of manpower . . . and, very often, a lack of experience in the new fields they planned to enter.

Here, in the Taft-Peirce Contract Division, they have had their lacks supplied by a compact, mobile organization with an all-inclusive store of experience, and a plant equipped to produce *economically* anything from a single production tool to complete mechanisms, machines, or products in carload lots. No job is too large, none is too small, and any phase of Taft-Peirce Contract Service may be engaged without the others.

Today, the roster of Taft-Peirce contract clients has extended so widely that it has become almost a country-wide commonplace to advise: "If you have a good idea —but not the time or experience to develop, tool up, or build it—then *Take It To Taft-Peirce.*"

Taft-Peirce Contract Service...

is described and illustrated in this interesting gravure volume, a copy of which you may obtain by writing on your letterhead to: *The Taft-Peirce Manufacturing Co., Woonsocket, Rhode Island.*

Reg. U. S. Pat. Off.

Samson Cordage Works

Boston, Mass.

Herbert G. Pratt, '85, *Chairman of the Board*

Manufacturers of braided cords of all kinds, including sash cord, clothes line, trolley cord, signal cord, shade cord, Venetian blind cord, awning line, etc., also polished cotton twines and specialties.

SAMSON SPOT CORD

Reg. U. S. Pat. Off.

Our extra quality sash cord, distinguished at a glance by our trade-mark, the colored spots. Especially well known as the most durable material for hanging windows, for which use it has been specified by architects for more than half a century.

Liquid WARTIME PRODUCTS

HELPING TO "LIQUIDATE" THE AXIS

- Parachute Flares
- Naval Ammunition Hoists
- Navy Mines
- Armor Piercing Shot
- Anti-aircraft Gun Bases
- Scullery Sinks
- Tank Turret Parts
- Airplane Controls and Collector Rings
- Machine Gun Turrets, Magazines and Ammunition Boxes
- Machine Tool Parts

• COMMERCIAL GASES

Carbon Dioxide (CO_2)
Oxygen
Acetylene
Hydrogen
Nitrogen
Dry Ice

• MEDICAL GASES

Ethylene, Oxygen, Helium
Helium-Oxygen Mixture
Oxygen-Carbon Dioxide Mixture
Nitrous Oxide
Carbon Dioxide

PEACETIME PRODUCTS

Beverage Bottling Machinery
Refrigerated Dispensing Equipment
Extracts and Flavors
Welding Equipment

The Liquid Carbonic Corporation
3110 South Kedzie Avenue, Chicago, Illinois
Branches in Principal Cities of the United States and Canada

CONVERSION AND THE CONFEDERACY

(*Concluded from page 160*)

which he thought so much that he applied for a patent, and Stephen R. Mallory, the Secretary of the Navy, issued him Confederate Patent No. 100 therefor. Casemates replaced the frigate top; their sides, inclined about 36 degrees, were made up of two layers of 12-inch timbers, covered with two layers of 2-inch iron sheets. A heavy iron wedge was inserted at the prow, for a ram. The ship was given a battery of six 9-inch Dahlgren smoothbores and four of Brooke's new naval rifles.

The designer-inventor went to the Tredegar Iron Works at Richmond so that he could personally superintend the preparation of the armor and plate for converting the old frigate into an armored man-of-war. When put to the test, everything worked well except the marine engines. Their replacement or repair was beyond the ability of the engineering shops at the Norfolk Navy Yard. Engine trouble crippled the *Merrimac* in the duel with the *Monitor*.

In March, 1863, Secretary Mallory appointed Commander Brooke chief of the bureau of ordnance and hydrography of the Confederate Navy. He handled this important task with great ability until the Confederate Government fled from Richmond early in April, 1865.

Reference has already been made to the Brooke gun as a part of the battery of the reconstructed *Merrimac* in 1862. The gun was considered at the time a distinct improvement on either of the two chief types of naval ordnance in use in the United States Navy, the smoothbore Dahlgren cannon and the Parrott rifle. Both of these were cast guns, as a result of which fact the powder chamber pressures which they could resist were limited. Both their range and accuracy of fire were thus impaired. Brooke's new gun barrel was cast, but he had undertaken to strengthen it by shrinking wrought-iron hoops or jackets on the outside, thus providing reinforced strength against greater powder pressures inside the gun. In addition, the powder chamber was so shaped that it served as an "air brake" to cut the initial tension of the gases. The new gun proved admirable in service. The *Merrimac* gunners used it most successfully, and later Confederate men-of-war did great execution with it. Admiral Buchanan's armored ram, the *Tennessee*, which did such damage to Farragut's fleet in the Battle of Mobile Bay in 1864, had a main battery of Brooke guns.

Commander Brooke proved most efficient in the exercise of his duties as chief of ordnance for the Confederate Navy. He gave active support to the development of torpedoes for use by Confederate naval and coast forces against the Federal blockaders. The result was torpedoes better than the world had known before, the employment of which sent several United States vessels to the bottom. He also did what he could to help experiments in Charleston Harbor on a submarine which had some small measure of promise through actual employment against ships in Admiral Dupont's squadron. Brooke ran his office well, and enjoyed the confidence of President Davis as well as Secretary Mallory and the chief fighting admirals of the Confederate Navy. After the war, he became a professor at Virginia Military Institute at Lexington, and served there many years. He died in 1906.

SPRAGUE MEG-O-MAX

HIGH-RESISTANCE, HIGH-VOLTAGE RESISTORS

Less than 3 months from the presentation to Sprague Koolohm Resistor engineers of the problem of designing high-resistance value units capable of dissipating power at voltages up to 20 kv. and at high ambient temperatures, the first Sprague Meg-O-Max Resistors were on the job! Moreover, they used practically no critical materials, were of smaller physical size, and presented a degree of resistance stability and mechanical ruggedness not available in other units, exclusive of costly wire-wound meter multiplier types!

Entirely unique in construction, Meg-O-Max Resistors are formed of a series of molded segments. These are joined non-inductively, and the assembly is then encased in a hermetically-sealed, rugged glass envelope provided with ferrule terminals to withstand aircraft vibration tests, salt water immersion tests, and tests for mechanical shock produced by rapid acceleration.

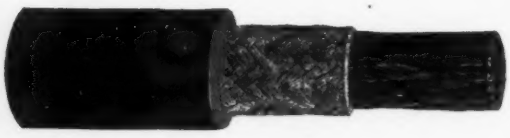
In addition to use as a high-voltage bleeder and as a broad accuracy meter multiplier for a voltage indicator, Meg-O-Max Resistors find many applications in measuring instruments, rectifier systems, high-voltage dividers, and as broad accuracy meter multipliers. Specify Meg-O-Max for High-Resistance—High-Voltage requirements.

Data sheets gladly sent upon request. Samples sent only on firm's request, giving details of application.

SPRAGUE SPECIALTIES COMPANY
Resistor Division • North Adams, Mass.

A NEW DEVELOPMENT BY THE MAKERS OF KOOLOHM TRADEMARK REGISTERED INSULATED WIRE-WOUND RESISTORS

SIMPLEX-TIREX
Electric Welding Cables



. . . for shipyards, railroads, pipe lines and any construction or repairs where electric welding contributes to efficient production.

Subject to W.P.B. regulations

SIMPLEX WIRE & CABLE CO.
79 Sidney Street, Cambridge, Mass.

57 years' experience
10 REPRODUCTION PROCESSES
At your Service
LIB. 3000
May we help
— solve your problem —
SPAULDING-MOSS CO.
42 Franklin Street
263 Park Sq. Building
113 Purchase Street
Boston, Mass.

MAIL RETURNS

(Concluded from page 128)

Egypt, the country that so far is the only one which can produce the long staple cotton used in the making of automobile tires, raises this cotton on lands that annually are flooded by the Nile River, and the people of Egypt pray every year for the Nile to overflow. Here in this country we build dikes to keep the water from flooding the farms.

We have been warned that in the next 75 years the famous Mississippi Valley will become a barren waste. But who has attempted to dissuade authorities from keeping the Mississippi River from flowing over the lands and fertilizing them with the rich mud that the river with its dikes is now carrying into the Gulf of Mexico, where it is lost forever?

As people, we become locally selfish when we allow or advocate the building of dikes to prevent the flooding of small sections of our town in which no building should ever have been erected. Do we realize that by so doing we are burdening communities farther down the river with an extra volume of water on top of the already flooded river instead of permitting this water to store itself naturally and flow off gradually?

Harrisburg had a 33-year-cycle flood in 1936. Some of the generation of engineers who will be here in, say, 1969 will experience the evil effect of the dikes built or being built on the upper reaches of the Susquehanna. Even before then, minor floods will occur.

Engineers building flood control dams have failed to take into account the fisherman. Every such dam built, including the largest one above Pittsburgh, the construction of which I advocated, has proved a total failure for the reason that a flood dam should be kept normally empty and be permitted to fill only during floods. But the fishermen, who are not without political influence, demand that these dams be kept filled for their pleasure. So that is that.

In conclusion, if we refrain from building either dikes or flood control dams at floodtimes, the people will in a future emergency have time to move to higher land and no lives will be lost. But if we hold the floodwaters back with man-made dams or dikes and permit the people to feel secure in their homes, then when these dams or dikes break, the loss of life is shocking.

Which should it be, people or property?

Harrisburg, Pa.

Fitting

FROM S. W. BENTON:

In the light of Fred Kelly's judicious appraisal of the Wrights' invention of the flying machine, in his very interesting article in your December issue, it seems to me to be extremely fitting that the original *Wright Flyer* is to be brought back to its native country as soon as circumstances will allow. Everyone who is proud of American ingenuity and inventiveness will look on the machine as a memento of one of the most impressive moments in the nation's history.

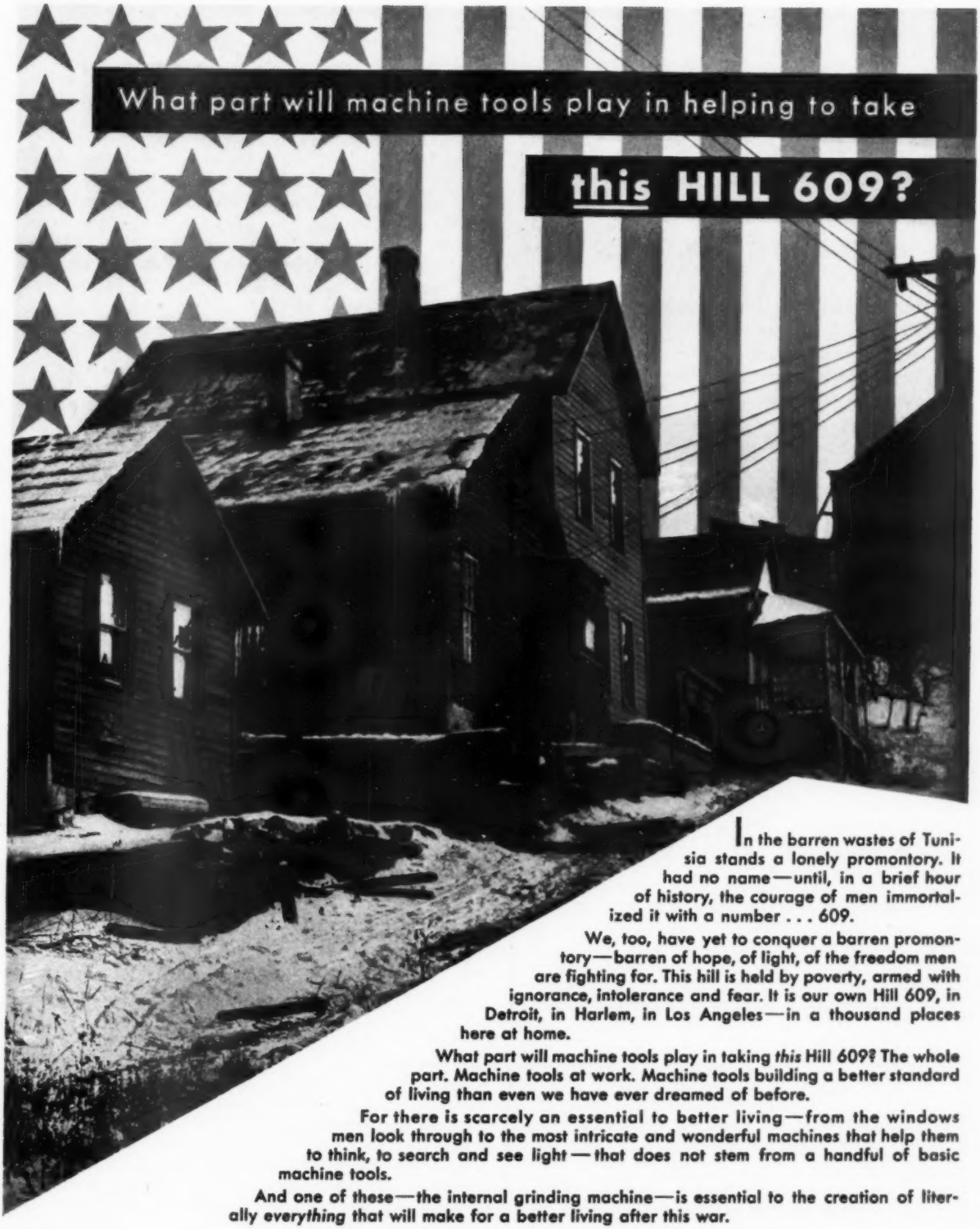
Spring Valley, N. Y.

New Products

A well established company with modern laboratories and an extensive sales force in various industries would welcome the opportunity to consider new ideas, chemicals or raw materials, with the view of assisting in their development and commercialization.

Reply to Box A

THE TECHNOLOGY REVIEW
M.I.T., CAMBRIDGE 39, MASS.



In the barren wastes of Tunisia stands a lonely promontory. It had no name—until, in a brief hour of history, the courage of men immortalized it with a number . . . 609.

We, too, have yet to conquer a barren promontory—barren of hope, of light, of the freedom men are fighting for. This hill is held by poverty, armed with ignorance, intolerance and fear. It is our own Hill 609, in Detroit, in Harlem, in Los Angeles—in a thousand places here at home.

What part will machine tools play in taking *this* Hill 609? The whole part. Machine tools at work. Machine tools building a better standard of living than even we have ever dreamed of before.

For there is scarcely an essential to better living—from the windows men look through to the most intricate and wonderful machines that help them to think, to search and see light—that does not stem from a handful of basic machine tools.

And one of these—the internal grinding machine—is essential to the creation of literally *everything* that will make for a better living after this war.

BRYANT CHUCKING GRINDER COMPANY SPRINGFIELD VERMONT, U.S.A.

TRADE MARK
HEVI DUTY
REGISTERED U. S. PAT. OFFICE

Hevi Duty Electric Co.

Electric Furnaces

MILWAUKEE, WISCONSIN

Hevi Duty Precision Electric Heat Treating Furnaces are built in a large variety of types and sizes — for many heat treating operations — with temperature ranges to 2500° F. (1371° C.). They are standard production equipment in many national industrial plants.

Write for descriptive bulletins

HAROLD E. KOCH '22, *President*

GEORGE A. CHUTTER '21, *Vice-President*

ELTON E. STAPLES '26, *On Leave, U. S. Army*

BRUNO M. WERRA '32, *Director of Research*

NO MORE CLASS OR SOCIAL FUNCTIONS FOR THE DURATION

Walker Memorial

Technology's Social Center

has

Gone to War!

The management thanks you for your past patronage and anticipates once again being the "Home for your Class Functions" after the war is won.

WALKER MEMORIAL DINING SERVICE

M. I. T.

Cambridge, Massachusetts

A. W. BRIDGES, *Mgr.*

THE TREND OF AFFAIRS

(*Continued from page 136*)

boundary of Montana. It has once been reported in extreme northwestern North Dakota. It is only a matter of time before the disease will be reported from the tier of states south of North Dakota, since it has practically reached the Texas border. Why, then, does plague not appear more often in man? Since 1940, about six such cases have been reported in western United States. With the exception of one near Boise, Idaho, they all occurred in Siskiyou County, Calif.

Plague does not seem to appear in the human population until the disease reaches a rather high level in the contiguous rodent population. There must also be present at the same time those sorts of fleas which are capable of transmitting plague from rodent to man. The plague bacilli have the power of multiplying in the intestine of the flea. In some species, this results in plugging the gut. When such a flea tries to feed, it often vomits up blood and bacilli, and the latter may enter the human body through the flea bite or the flea may be crushed and the germs set free. Experiments indicate that plague is most efficiently carried by those kinds of fleas which suffer this blockage of the gut. Although the tropical rat fleas which are mostly associated with domestic rodents are the best-known transmitters, several fleas on our own wild rodents are effective. The rat fleas mentioned are more prone to transmit from rodent to man since they do not object to biting man. In some epidemics, plague of the lungs (pneumonic plague) occurs and is passed directly from victim to victim without the help of fleas. The death rate for this form is, as a rule, very high.

It is not unlikely that almost any rodent is capable of contracting plague, and some 20 kinds of wild rodents in the western United States have been found infected. For the most part, these are ground squirrels and prairie dogs. Perhaps their somewhat sociable habits make for an easier spread of the disease than we find in rabbits and mice, but it is not by any means unknown among the latter types.

The outlook for plague in North America can be based on four facts: (1) The known area of distribution of rodents has increased much faster in the last eight years than it did in the preceding 30 years. This situation is typical of the spread of an introduced organism. (2) There exists no real barrier to the further eastward spread of the disease. It has not yet reached the eastern limits of distribution of its main rodent hosts in the West. (3) Except on the coast of California, it has scarcely come into contact with large populations of domestic rodents. (4) The small number of human cases in the last few years seems to indicate only that the disease is not at the present time sufficiently abundant among rodents in a region with a dense human population. One of the most recent cases was in a man who had been hunting ground squirrels.

We may conclude that ere long the plague will meet the larger populations of domestic rats in the relatively populous cities just west of the Mississippi. The rats there have been long free of the disease and should be

(*Concluded on page 168*)

ESTABLISHED 1818

Brooks Brothers

CLOTHING

Men's Furnishings, Hats & Shoes

MADISON AVENUE COR. FORTY-FOURTH STREET
NEW YORK

IT PAYS TO BE SURE

One of the many great advantages in doing business with Brooks Brothers through these difficult times is the certainty that whatever you purchase is right. Any investment you make in things from this store will stand up in value and pay substantial dividends in use, wear, and general satisfaction.

Good taste, sound judgment and an unsurpassed experience in picking the right things all play their part in the selection of every article of merchandise offered for sale.

Now in the Second Quarter of our Second Century 1818–1944

BRANCHES
NEW YORK: ONE WALL STREET
BOSTON: NEWBURY COR. BERKELEY STREET

Air Conditioning Synthesis

SOMETIMES when we are asked what arts and sciences are synthesized in scientific air conditioning, we hardly know what to answer.

After listing the obvious ones, we look at the titles of some of the books we use in our reference library:

STEAM POWER STATIONS
CHEMICAL ENGINEERING PLANT DESIGN
FORMULAS FOR STRESS AND STRAIN
MATHEMATICS FOR ENGINEERS
AIRPLANE STRUCTURAL ANALYSIS AND DESIGN

Would you believe it?

HAROLD J. RYAN, INC.

101 Park Avenue, New York City

BLUEPRINTS *VS.* BOTTLENECKS

Don't allow delay in receiving blueprints to hold up production.

Such hold-ups stymie your efforts as much as delayed materials.

ELECTRO SUN SERVICE means you receive prints on time.

Also, we have a complete plant for **PHOTO PRINTS** and **OFFSET PRINTING**—all under one roof.

WE'LL HELP KEEP 'EM ROLLING AND FLYING

ELECTRO SUN CO., INC. NEW YORK, N.Y.
PHOTO LITHOGRAPHS • BLUEPRINTS • PHOTO COPIES • LITHOPRINTS
161 WASHINGTON STREET BArclay 7-2334
GRAND CENTRAL TERMINAL BLDG MUrray Hill 6-6526

J. C. DUFF '86 A. L. WEIL '01

To Tech Men and Others—
If you have trouble with your
PACKING FOR VALVES, PUMPS and other machinery
consult
HENRY D. JACKSON '95
29 NOYES STREET, CONCORD, NEW HAMPSHIRE

THE TREND OF AFFAIRS

(*Concluded from page 166*)

ripe for their own private epidemic, which they probably will not keep to themselves. There will be outbreaks in man which, after a time, will subside. Once established in a sizable population of domestic rodents, the disease should continue its eastward march without further difficulty.

In these conclusions of course lies the obvious and inescapable further conclusion that the course of wisdom is to start and to continue actively the common sense methods of precaution and prevention.

Cohue

GLASS fibers are used as reinforcement in a new plastic material employed in aircraft construction, experimental samples of the combination having been produced with tensile strengths of more than 80,000 pounds per square inch. Impact resistance of more than 20 foot-pounds, as compared with about two foot-pounds reported for untreated plastics in a standard test, has been shown by test samples of the new compound. ¶ Dehydration's progress during the year past is suggested by figures showing that hardly any meat was so processed in 1942, that 60,000,000 pounds were handled in 1943, and that 18 plants dried 10,000,000 pounds of eggs in 1940 as against 315,000,000 pounds dehydrated by 94 plants during 1943. ¶ A synthetic rubber is used to line the concrete walls of underground tanks for the storage of fuel oils. Heavy fuels were no problem but when lighter oils such as Diesel fuel and aviation gasoline showed a tendency to seep through the pores of the concrete, research produced a lining which is cemented to the tank walls much as wallpaper is hung in decorating a dwelling house.

PREPARATORY SCHOOLS FOR BOYS

CHAUNCY HALL SCHOOL

Founded 1828. The School that confines itself exclusively to the preparation of students for the Massachusetts Institute of Technology.

FRANKLIN T. KURT, *Principal* 553 Boylston Street, *Boston, Mass.*

HUNTINGTON SCHOOL FOR BOYS

Four forms beginning with 9th grade.
Thorough preparation for entrance to M.I.T. and other technical schools.
Regular and accelerated courses.
Arthur E. Newcomb, Jr., Ed.M., Principal
320 Huntington Ave., Boston Tel. Kenmore 1800

Boit, Dalton & Church
INSURANCE

89 BROAD STREET
BOSTON, MASS.

Hubbard
3100

KENmore 0119 KENmore 0120

HARTY-BLANEY CONSTRUCTION CO.

25 Huntington Avenue

Boston **Massachusetts**

Walter C. Blaney John J. Harty '13

The

RUMFORD PRESS

CONCORD
NEW HAMPSHIRE

WHERE

Printing

IS STILL A CRAFT

PEQUOT
SHEETS
AND
PILLOW CASES

When the big war job is done there will be plenty of Pequots for waiting millions of housewives.

PEQUOT MILLS
Salem, Mass.

HENRY P. BENSON
President

— Class '86

McCREERY and THERIAULT

Building Construction

131 CLARENDON STREET BOSTON, MASS.

WILLIAM D. NEUBERG COMPANY

Chemicals

GRAYBAR BUILDING · 420 LEXINGTON AVE.
NEW YORK, N. Y.
TELEPHONE LEXINGTON 2-3324

William H. Coburn, '11 William F. Dean, '17

William H. Coburn & Co.

INVESTMENT COUNSEL

68 Devonshire St. Boston, Mass.

Transits and Levels are used on all largest works and by U.S. Govt. for utmost precision. Rental Insts. *New catalog, just issued, sent gratis. A souvenir plumb-bob sent for 3¢ postage.*
BUFF & BUFF CO. Boston 30, Mass.
Henry A. Buff '05

POST WAR
ELECTRICAL K-A WARP STOPS
Trade Mark Reg. in U. S. Pat. Off.
Will enable all sorts of looms to weave
"Better Cloth at Less Cost"
R. I. WARP STOP EQUIPMENT CO.
PAWTUCKET, RHODE ISLAND

MONSANTO CHEMICAL COMPANY
Merrimac Division
EVERETT
MASSACHUSETTS
The largest and oldest chemical manufacturer in New England

THE INSTITUTE GAZETTE

(*Concluded from page 148*)

that though Hitler had realized this fact, Hitler had evidently far underestimated what the scientists and engineers arrayed against him would be able to accomplish.

English in Wartime

WARTIME problems of the teaching of English and history at the Institute were surveyed by Philip W. Moore, 01, chairman of the Corporation Visiting Committee on the Department of English and History during 1942–1943, in a recent report summarized below:

Soon after the last meeting of the Visiting Committee on the Department of English and History in March, 1942, the Department offered an option in American history, designed to give the students a better conception of American history and traditions than they might have acquired from the conditions under which they grew up. It was a fortunate move, because the option with slight modifications fits the Army and Navy first-year programs. A broader course in the same subject is offered to all civilians at the Institute. Since the servicemen enrolled in these courses have had a great variety of educational background; since no time is available for outside preparation of classwork and everything must be done in the classroom; and since fatigue has been in evidence to some degree, some concern was felt that the servicemen might not do so well in these courses as the civilians. Last August, however, after the courses had been in operation for 11 weeks, the records of such men compared favorably with those of the civilians.

The staff of the Department has been increased somewhat to take on the added load, but even so, with four full sections, each member of the staff carries 12 hours of teaching a week. Two members of the Department of Modern Languages and one from the School of Architecture are lending part of their time to the teaching of English and history.

It might well have been expected that the demands of the War Department and the Department of the Navy upon their personnel enrolled at the Institute would be so heavy as to bring about the abandonment of much of the material taught in this Department. Fortunately, however, the Department was able to present its subjects in such a way that continuation of its courses was found well worth while. The spirit of the Department is excellent.

PERSONAL RESEARCH into the future leads to life insurance as the solution to freedom from want

STANLEY W. TURNER '22

former student of M. I. T. will be glad to give you the facts.

Telephone CAPitol 0456 or address
30 State Street, Boston, Mass.

PROVIDENT MUTUAL
LIFE INSURANCE COMPANY
OF PHILADELPHIA, PENNSYLVANIA

PROFESSIONAL CARDS

JACKSON & MORELAND
Engineers

Public Utilities — Industrials
Railroad Electrification
Design and Supervision — Valuations
Economic and Operating Reports

BOSTON NEW YORK

H. K. BARROWS, '95
M. Am. Soc. C. E.

CONSULTING HYDRAULIC ENGINEER

Hydro-electric Developments — Water Supplies. Reports, Plans, Supervision. Advice, Appraisals.

6 BEACON STREET · BOSTON, MASS.

EADIE, FREUND AND CAMPBELL
CONSULTING ENGINEERS

110 WEST FORTIETH STREET NEW YORK CITY

Plans and Specifications — Examinations and Reports

Power, Heating, Ventilating, Electric, Plumbing, Sprinkler, Refrigerating, Elevator Installations, etc., in Buildings and Industrial Plants

J. K. CAMPBELL, M. I. T. '11

STARKWEATHER ENGINEERING CO.
INCORPORATED

Engineers and Contractors for Pumping Plants Boiler and Power Plants, Cooling Water and Heat Recovery Systems

246 Walnut Street, Newtonville BIGelow 8042

Wm. G. Starkweather, M.E. Cornell '92 — J. B. Starkweather, B.S. M.I.T. '21

H. A. KULJIAN & CO.

CONSULTANTS · ENGINEERS · CONSTRUCTORS

Specialists in

UTILITY, INDUSTRIAL and CHEMICAL FIELDS

1518 WALNUT STREET PHILADELPHIA, PA.

H. A. KULJIAN '19

FABRIC RESEARCH LABORATORIES
INCORPORATED

Research, Testing and Consulting for Textile and Allied Industries

665 Boylston Street Boston, Mass.

W. J. HAMBURGER, '21 K. R. FOX, '40 E. R. KASWELL, '39

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS

Allen W. Reid '12 — Malcolm G. Davis '25, *Vice President* — F. E. Drake '05

Steam, Hydro, Diesel Power Plants; Industrial Structures; Plant Safety, Labor Relations, Utility Rates, Valuations, Reports; Large Scale Purchasing; Industrial Laboratory

New York, 61 Broadway — Reading, Pa., 412 Washington St. — Washington, Nat'l Press Bldg.

FAY, SPOFFORD & THORNDIKE

ENGINEERS BOSTON, MASS.

BRIDGES WATER SUPPLY AND SEWERAGE
PORT AND TERMINAL WORKS
FIRE PREVENTION
INVESTIGATIONS DESIGNS
SUPERVISION OF CONSTRUCTION

STANLEY G. H. FITCH '00
CERTIFIED PUBLIC ACCOUNTANT

of PATTERSON, TEELE & DENNIS, 1 Federal Street, Boston, Mass.
Cost Accountants and Auditors — Tax Consultants

NEW YORK BOSTON WASHINGTON

REPRESENTATIVES IN OTHER PRINCIPAL CITIES OF THE UNITED STATES, CANADA, ENGLAND AND AUSTRALIA

MAURICE A. REIDY
Consulting Engineer

BRIDGES BUILDINGS
STRUCTURAL DESIGNS FOUNDATIONS
CONSTRUCTION CONSULTANT AND ARCHITECTURAL ENGINEER

Estimates and Appraisals

44 SCHOOL STREET BOSTON, MASS.

THE COSMA LABORATORIES CO.
1545 East 18th Street Cleveland 14, Ohio

Chemical Analysis — Testing — Consulting Engineering
Testimony and Research

H. SEYMOUR COLTON, M.I.T. '21, *Director* — R. W. FRISCHMUTH, Case '38, *Assistant Director*

MORAN, PROCTOR, FREEMAN & MUESER
CONSULTING ENGINEERS

420 LEXINGTON AVENUE NEW YORK CITY

Foundations for Buildings, Bridges and Dams;
Tunnels, Bulkheads, Marine Structures;
Soil Studies and Tests;
Reports, Design and Supervision.

WILLIAM H. MUESER, '22

CALIBRON PRODUCTS, INC.
Industrial Physics

Mechanics and Electricity — Apparatus Built to Order

"GUARANTEED RESEARCH" — *An Unusual Service*

51 Lakeside Avenue West Orange, New Jersey

HOMER T. BROWN CO.
Realtors

Real Estate Brokers *Property Management*
Appraisals and Mortgages

1320 BEACON STREET BROOKLINE, MASS.

Edgar P. Palmer '25 William W. Russell '22

AN AID TO INDUSTRY IN LOCATING OUTSTANDING MEN

INDUSTRY IS LOOKING FOR:

Communication Engineers • Field Engineers • Industrial Engineers • Mechanical Engineers • Physicists • Sales Managers Technical Salesmen

For Further Information

WRITE

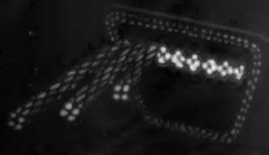
PLACEMENT BUREAU

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAMBRIDGE 39, MASS.

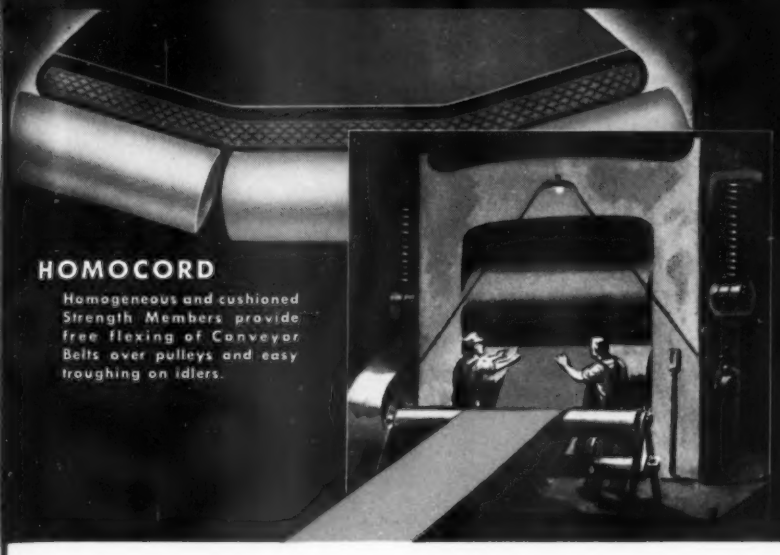
AN AID TO ALUMNI IN FINDING DESIRABLE POSITIONS

MANHATTAN



CONDOR V-BELTS

Whipcord construction gives flexibility, strength and extreme lack of stretch.



HOMOCORD

Homogeneous and cushioned Strength Members provide free flexing of Conveyor Belts over pulleys and easy troughing on idlers.

STRENGTH MEMBERS

. . . are the *SINEWS* of FLEXLASTIC* Rubber Muscles

Condor PRODUCTS

- Conveyor and Elevator Belt
- Compensated Belt
- Transmission Belt
- V-Belt
- Air Hose
- Contractors Hose
- Fire Hose
- Hydraulic Hose
- Oil and Gasoline Hose
- Sand Blast Hose
- Steam Hose
- Suction Hose
- Water Hose
- Chute Lining
- Launder Lining
- Industrial Brake Blocks and Lining
- Molded Rubber Goods
- Rubber Lined Tanks
- Rubber Covered Rolls

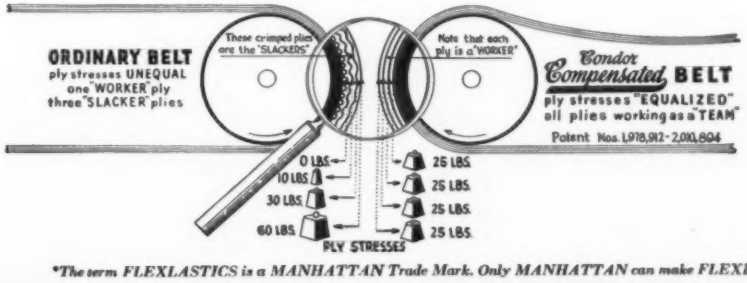
- Abrasive Wheels
- Bowling Balls

Just as the sinews hold together and strengthen the muscles without limiting their freedom of movement, so MANHATTAN STRENGTH MEMBERS reinforce and strengthen the FLEXLASTICS*, at the same time that they enhance their flexibility and durability.

MANHATTAN STRENGTH MEMBERS are "engineered," each one for a specific service, fabricated and scientifically located in the precise area or section where they contribute the most to structural life and capacity—just as in engineering design of bridges or trusses. Members of suitable materials, correctly proportioned and treated, are properly placed with respect to all other component parts.

Examination of the diagram below of ordinary and Condor Compensated Belt illustrates clearly what correctly designed strength members accomplish in performance, longer life and notably lower ultimate cost of power transmission. It is an economy which extends beyond the belt itself, to bearing and machine and to uninterrupted production.

Similar advantages result from a long line of exclusive MANHATTAN developments, such as the Homocord principle for Conveyor Belts; Condor Whipcord Endless Belts with Extensible Tips; Condor Whipcord V-Belts; Homoflex Hose in air, water, spray and other types; MANHATTAN Fire Hose with Radio-Active Mildew-Proof Treated Jackets, and many others.



*The term *FLEXLASTICS* is a MANHATTAN Trade Mark. Only MANHATTAN can make FLEXLASTICS.*

51st YEAR OF RESEARCH

The record of the first 50 years of accomplishment is the pledge for the second half-century MANHATTAN is now entering with research, testing, care and inspection as a basic policy, so there may be unbroken continuity to its contribution to industry. It will always be sound policy to keep ahead with MANHATTAN.

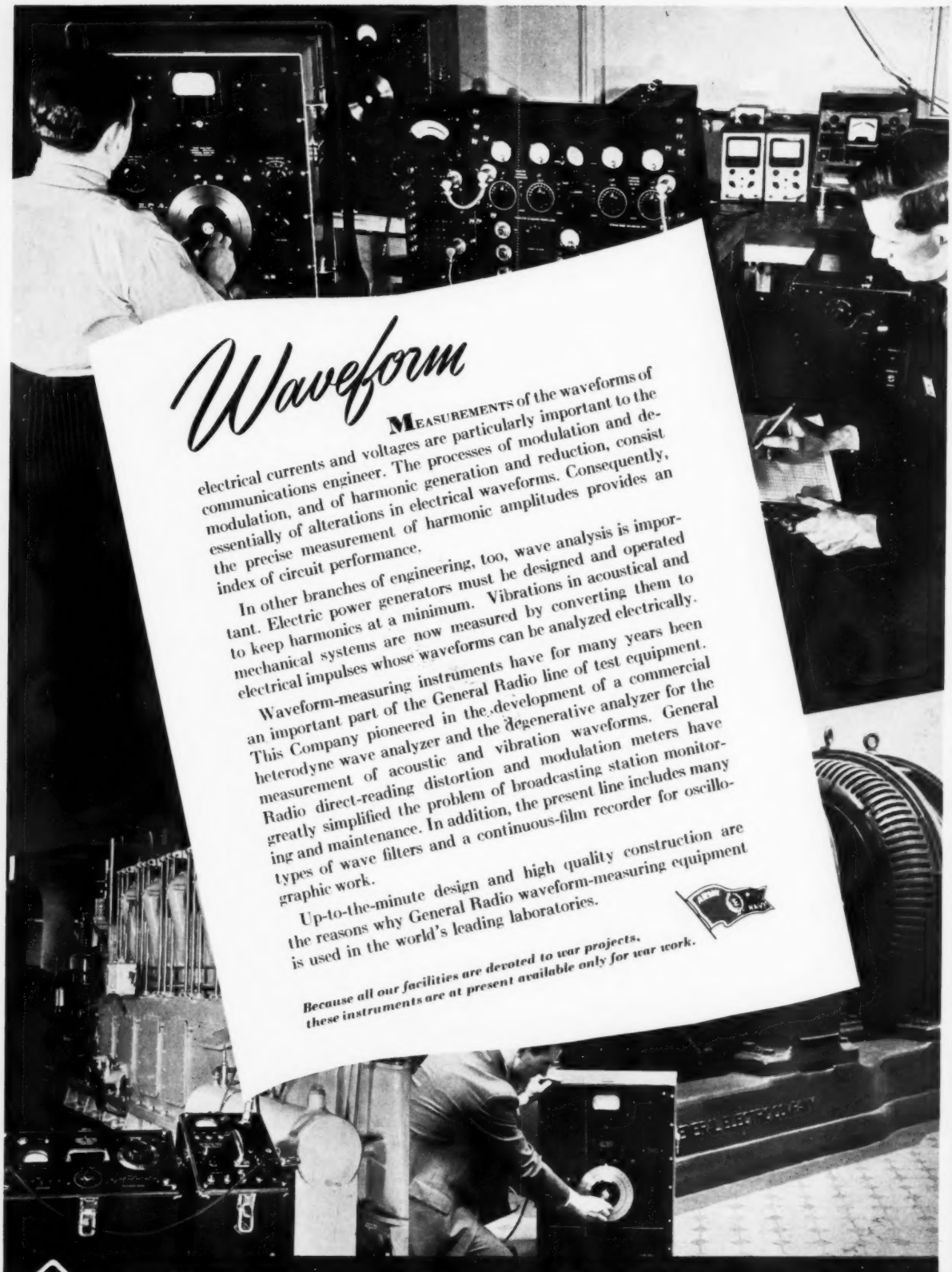
KEEP AHEAD WITH MANHATTAN

THE MANHATTAN RUBBER MANUFACTURING DIVISION

of RAYBESTOS-MANHATTAN, INC.

EXECUTIVE OFFICES PASSAIC, NEW JERSEY

Thomas H. Boyd, '23 Wilder E. Perkins, '25 Charles P. McHugh, '26 Daniel J. Hanlon, '37 Albert W. Beucker, '40



Waveform

MEASUREMENTS of the waveforms of electrical currents and voltages are particularly important to the communications engineer. The processes of modulation and demodulation, and of harmonic generation and reduction, consist essentially of alterations in electrical waveforms. Consequently, the precise measurement of harmonic amplitudes provides an index of circuit performance.

In other branches of engineering, too, wave analysis is important. Electric power generators must be designed and operated to keep harmonics at a minimum. Vibrations in acoustical and mechanical systems are now measured by converting them to electrical impulses whose waveforms can be analyzed electrically.

Waveform-measuring instruments have for many years been an important part of the General Radio line of test equipment. This Company pioneered in the development of a commercial heterodyne wave analyzer and the degenerative analyzer for the measurement of acoustic and vibration waveforms. General Radio direct-reading distortion and modulation meters have greatly simplified the problem of broadcasting station monitoring and maintenance. In addition, the present line includes many types of wave filters and a continuous-film recorder for oscillographic work.

Up-to-the-minute design and high quality construction are the reasons why General Radio waveform-measuring equipment is used in the world's leading laboratories.

Because all our facilities are devoted to war projects, these instruments are at present available only for war work.

GENERAL RADIO COMPANY Cambridge 39, Massachusetts
NEW YORK CHICAGO LOS ANGELES